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AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE STORY OF THE CHEMICAL ELEMENTS[1]

TO-NIGHT I am to present to you a few sketches from the story of the chemical elements during the last three decades—a period during which that story has developed into an exciting drama.

Let me begin by briefly reviewing the state of our knowledge of the elements at the beginning of the century. Of the 89 elements now known about a dozen, including all the radioactive elements and several of the rare-earth elements, were still undiscovered. The chemical world had, only a few years previously, been excited by the discovery of two inert elementary gases—argon by Lord Rayleigh and Sir William Ramsay in 1894, and helium by the latter in 1895—two elements utterly different in their properties from any then known; and there had just been announced (in 1898) by Ramsay and Travers the isolation from the air of three more of these gases, neon, krypton and xenon, forming with argon a new very distinct group of the periodic system. The discoveries of argon and helium were especially striking; for argon had existed unknown through the centuries, though present to an extent of nearly one per cent. in the atmosphere; and helium had been detected in the sun by its spectrum long before it was found on the earth. Some of you will recall that Professor Ramsay exhibited in this country a few years later a minute bubble of helium and showed its spectrum—a substance that is now prepared in quantity large enough to fill huge dirigibles. And it is interesting to note that two other of these then rare gases, argon and neon, are now used for filling each year thousands of electric lamps. But of far greater importance was the bearing of the discovery of helium on the development of subatomic physics and chemistry, as we shall soon see.

Thirty years ago the periodic relations of the elements were commonly represented [in the way shown in Figure 1] by arranging the elements in the order of their atomic weights in periods of eight. This arrangement was fairly satisfactory for practical use; but it had many familiar defects—some of which suggested real theoretical difficulties.

[1] Address delivered at the New York meeting of the American Association for the Advancement of Science by its retiring president.

PERIODIC CLASSIFICATION OF THE ELEMENTS

	I		II		III		IV		V		VI		VII		VIII			O
1	1 H 1.008																	2 He 4.00
2	3 Li 6.94		4 Be 9.1		5 B 10.9			6 C 12.005		7 N 14.008		8 O 16.00		9 F 19.0				10 Ne 20.2
3	11 Na 23.00		12 Mg 24.32		13 Al 27.0			14 Si 28.1		15 P 31.04		16 S 32.06		17 Cl 35.46				18 A 39.9
4	19 K 39.10		20 Ca 40.07		21 Sc 45.1		22 Ti 48.1		23 V 51.0		24 Cr 52.0		25 Mn 54.93		26 Fe 55.84	27 Co 58.97	28 Ni 58.68	
		29 Cu 63.57		30 Zn 65.37		31 Ga 70.1		32 Ge 72.5		33 As 74.96		34 Se 79.2		35 Br 79.92				36 Kr 82.92
5	37 Rb 85.45		38 Sr 87.63		39 Yt 89.33		40 Zr 90.6		41 Cb 93.1		42 Mo 96.0		43		44 Ru 101.7	45 Rh 102.9	46 Pd 106.7	
		47 Ag 107.88		48 Cd 112.40		49 In 114.8		50 Sn 118.7		51 Sb 120.2		52 Te 127.5		53 I 126.92				54 Xe 130.2
6	55 Cs 132.81		56 Ba 137.37		Rare Earths				73 Ta 181.5		74 W 184.0		75		76 Os 190.9	77 Ir 193.1	78 Pt 195.2	
		79 Au 197.2		80 Hg 200.6		81 Tl 204.0		82 Pb 207.20		83 Bi 209.0		84		85				86
7	87		88		89		90 Th 232.15		91		92 U 238.2							

Fig. 1

(1) There were many gaps, assumed to represent undiscovered elements.

(2) Certain pairs of elements, potassium and argon, cobalt and nickel, tellurium and iodine, had to be placed in the reverse order of their atomic weights; for they would otherwise be out of place with respect to the sequence of properties.

(3) Hydrogen and helium were isolated elements, not related to the groups of eight.

(4) A large number of rare-earth elements had to be put in place of the single element lanthanum.

(5) Sets of three elements (iron, cobalt, nickel; ruthenium, rhodium, palladium; and osmium, iridium and platinum) were substituted for single ones in the eighth group.

(6) One had to cross the table to pass from the last of these three triplets to the next element, although the properties form a continuous sequence, as in the cases of nickel and copper or of platinum and gold.

(7) The grouping of elements was unnatural in many instances; thus, copper, silver and gold would appear from their position to be closely related to sodium and potassium; manganese to chlorine and bromine; and chromium, molybdenum and tungsten to sulfur and selenium.

Compare now this older periodic arrangement with one of the more recently published tables—for example, that of von Antropoff, shown in Figure 2. This conforms to the recent knowledge of the structure of atoms. It reverts, to be sure, to one of the arrangements of Mendeléeff, later revised by Thomson, with short periods of eight elements and long

O	I	II	III	IV	V	VI	VII
He 2	Li 3	Be 4	B 5	C 6	N 7	O 8	F 9
Ne 10	Na 11	Mg 12	Al 13	Si 14	P 15	S 16	Cl 17

O	Ia	IIa	IIIa	IVa	Va	VIa	VIIa	VIII			Ib	IIb	IIIb	IVb	Vb	VIb	VIIb
Ar 18	K 19	Ca 20	Sc 21	Ti 22	V 23	Cr 24	Mn 25	Fe 26	Co 27	Ni 28	Cu 29	Zn 30	Ga 31	Ge 32	As 33	Se 34	Br 35
Kr 36	Rb 37	Sr 38	Y 39	Zr 40	Nb 41	Mo 42	43	Ru 44	Rh 45	Pd 46	Ag 47	Cd 48	In 49	Sn 50	Sb 51	Te 52	I 53
X 54	Cs 55	Ba 56	La-Lu 57-71	Hf 72	Ta 73	W 74	Re 75	Os 76	Ir 77	Pt 78	Au 79	Hg 80	Tl 81	Pb 82	Bi 83	Po 84	85
Rn 86	87	Ra 88	Ac 89	Th 90	Pa 91	U 92											

Fig. 2

periods now with eighteen or thirty-two elements; but it is the work of Bohr and other investigators of atomic structure which has justified this arrangement and established it as most satisfactory.

This table, with its device of connecting zones, is probably as complete a representation of the relationships of the properties of the elements as can be afforded by any simple type of periodic table not directly representing the structure of the atoms. The table has the following advantages over the earlier one:

(1) All but three of the gaps have now been filled by the discoveries of new elements; most of which were made through studies of radioactivity and of the emission of X-rays.

(2) The inverted position of the elements argon and potassium, cobalt and nickel, tellurium and iodine, is fully justified now that atomic-structure studies have shown that it is not the atomic weight, but another characteristic, the atomic number, that determines nearly all the properties of the elements.

(3) Hydrogen and helium still form a pair by themselves; but this is clearly required by our knowledge of the structure of their atoms.

(4) The rare-earths still seem to be intruders; but this is only because the long period of 32 elements indicated by the structure of the atoms is, to avoid clumsiness, not shown in the table.

(5) The triplets now assume natural positions in the middle of the long periods; and form a continuous sequence with the next similar elements.

(6) There is now no break, but a progression, between these triplets and the succeeding elements, thus between nickel and copper, or platinum and gold.

(7) The relationships of the properties are much more fully indicated. Thus lithium and sodium are very closely connected with their nearest allies, potassium, rubidium and cesium; and they are also connected, but only remotely, with their distant relatives, silver, copper and gold. And the connecting zones lead directly from sulfur to selenium and tellurium, but only remotely to chromium, molybdenum and tungsten.

The periodic relations early impressed investigators with the conviction that the atoms of the various elements must have related structures, and must be built up progressively out of simpler units. Indeed, shortly after Dalton in 1803 developed the atomic theory, Prout proposed, purely as a speculation, without experimental basis, the hypothesis that all elements consist of hydrogen, and that therefore the weights of their atoms are exact multiples of the weight of the hydrogen atom. Prout's hypothesis was carefully tested during the next half century, as atomic-weight determinations became more accurate, by many careful investigators. It died hard, because of the indisputable facts—first, because some of the most important atomic weights (for example, those of helium, carbon, nitrogen, oxygen, fluorine, sodium and aluminum) are related to one another almost exactly as whole numbers, and second, because a far larger proportion of all the atomic weights have values within say 0.1 unit of a whole number than could happen by chance. Prout's hypothesis was, however, fully discredited as a general principle by the exact atomic-weight work of Stas in 1860–1865—but only to be revived again, as we shall see, by the development of subatomic considerations.

Let us now note the ideas about the atom itself that prevailed thirty years ago. Atoms were then regarded as ultimate entities, inscrutable with respect to their internal structure. It is true that the kinetic theory of gases, which postulated molecules as elastic spheres of definite dimensions, gave some insight into the size of molecules; and there were indications that the atoms within the molecules had diameters of the same general magnitude—of the order of a few hundred-millionths of a centimeter or of one hundred-millionth of an inch. Moreover, much was learned about the union of atoms to form molecules: indeed, upon this basis the great science of organic chemistry was created—probably the most extensive body of science and technology that was ever developed mainly through theoretical considerations. To each atom were assigned a certain number of bonds or valences; but there was no means of looking within the atom—of learning anything about its own structure or about the origin of these valences that are of such vital importance to the chemist.

Only two or three years, however, before the beginning of the period we are considering, three discoveries were made which were to lead during that period to the new sciences of electronic physics and subatomic chemistry. These were, first, the detection by J. J. Thomson and Kaufmann in 1897, in the long-known cathode rays, of the electron as an isolated electrified particle; second, the discovery of X-rays by Röntgen in 1895; and third, the discovery of radioactivity (in uranium) by Becquerel in 1896. And these discoveries were soon supplemented by the conception of energy-quanta by Planck (in 1900) and its extension by Einstein (in 1905) and by others.

It is obviously impossible in a single lecture even to outline the development of this vast field of research. I shall only attempt to sketch in a popular way a few of the well-established principles concerning the structure of atoms which bear upon the relations of the various elements to one another, not trying to describe their historical sequence or to explain their experimental basis.

First of all, as to the general nature of the atom. The theory proposed by Rutherford in 1911 has received through the years ever-increasing confirmation.

According to this theory the atom is a small-scale solar system: it consists, as is well known, of a very minute positively charged nucleus surrounded by mobile (negatively charged) electrons. In the case of hydrogen there is only one outer electron outside a nucleus having a unit-charge of positive electricity, which is equal and opposite to the negative charge on the electron. But with each succeeding element the number of outer electrons increases by one, and correspondingly the nucleus acquires one more positive unit-charge. Thus the neutral atom of helium has two outer electrons and a nucleus with two positive charges; that of oxygen has eight electrons and a nucleus with eight positive charges; that of uranium, the heaviest atom, 92 electrons and a nucleus with 92 positive charges. The charge on the nucleus, which increases steadily with the sequence of the elements, is often called the atomic number of the element.

Both the absolute mass and the charge of the electron are known within the surprisingly small error of 0.1–0.2 per cent. The mass or weight of the electron is only 1/1840 of that of the hydrogen atom; it is so light that it would take 10^{27} of them (1 followed by 27 ciphers) to weigh one gram.

The sizes of atoms and of their nuclei, as measured by the closest approach of other atoms or of other nuclei, are also approximately known. Thus the helium nucleus has a radius of about 10^{-12} cm, and the helium atom one 10,000 times larger or about 10^{-8} cm, a quantity which represents of course the distance of the electrons from the nucleus. To get a true picture of the atom one must visualize the relative values of these radii. Thus if the helium nucleus were magnified so as to be represented by a sphere of 1 cm radius, its two outer electrons would be located about 100 meters away: if the helium nucleus were a teed-up golf ball, the electrons would be on a green 200 yards away. An atom is therefore, like the solar system, "mostly hole," as Millikan has said.

Finally we now know, often with great accuracy, the energy which must be expended in order to remove many of the various electrons from the neighborhood of the nucleus. And upon the basis of this knowledge there can be constructed a chart [Figure 3] showing, in a way free from any uncertain hypothesis, the electronic structure of the atoms as a progressive and periodic property of the elements. This chart I presented and discussed at the Reno meeting of the Pacific Division of this association.[2] I call attention to it here mainly in order that, in our subsequent discussion of the nucleus, we may not forget the outer electrons and the extensive knowledge we have of them. The abscissas in the chart are the atomic numbers or nuclear charges, and the ordinates are the square-roots of the energies which must be added to the atom in order to remove the various electrons. The black circles represent the electrons, and their location shows their grouping and their energies of removal. The electron arrangements shown by the chart clearly account for the periodic relations of the elements. (This was briefly illustrated by the speaker.)

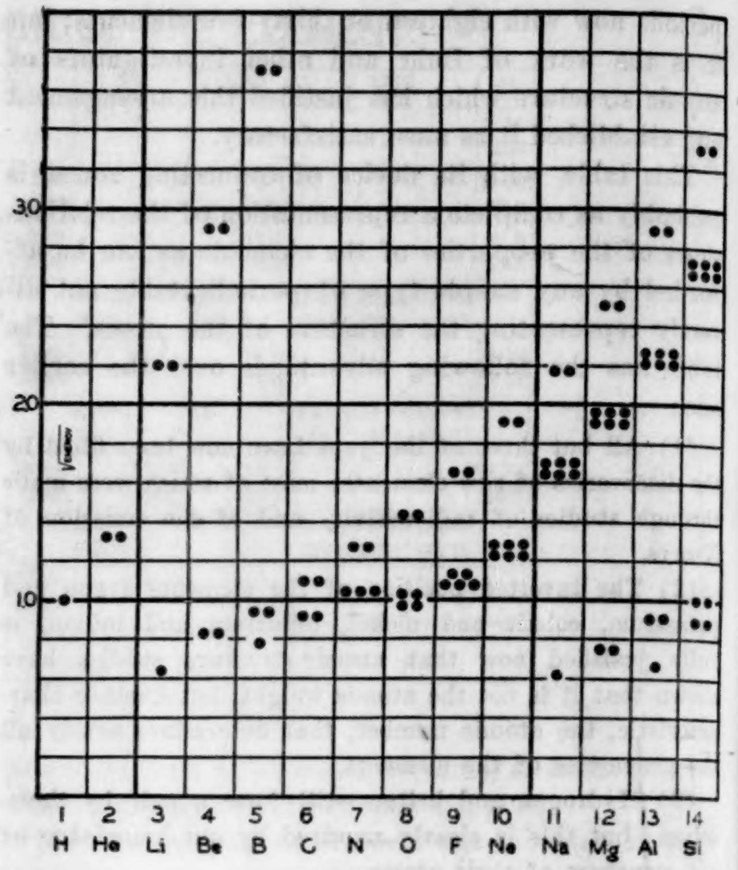

FIG. 3

Knowledge of the atom has evidently two distinct aspects—the nature of the nucleus and the relations of the outer electrons to it and to one another. This lecture is to be devoted mainly to the nucleus, and we must turn our attention to it without more delay. What is the structure of the nucleus? Whence arises its mass, and whence its positive charge, increasing progressively by one unit with each successive element? To these questions the investigations of the last twenty years have given fairly definite answers: they have demonstrated the composition of atom nuclei, though they have taught us very little about the dynamic relations involved. Namely, we are confident that the nuclei of the different atoms are built up through the association of various numbers of protons and electrons—a proton being the positive nucleus of the hydrogen atom, left after its electron is removed. Thus to account for the facts that the helium nucleus has a weight 4 and a positive charge 2, we assume that it consists of four protons and two electrons. The two electron-charges neutralize two

[2] See Noyes and Beckman, *Chemical Reviews*, 5, 85–107 (1928).

of the four proton-charges, giving a net positive charge of two units; but the electrons, since each has only 1/1840 of the mass of a proton, contribute scarcely anything to the mass or weight of the nucleus.

Let us play with these black and gray discs, and see what we can build out of them. The black discs represent protons or hydrogen nuclei: they are heavy, being made of metal. Consider that each has the weight of one proton, and that each black area facing you represents one unit of positive charge—one proton-charge. The gray discs are electrons: they are light (made of paper), each weighing 1/1840 of a proton, and each gray area facing you represents one unit of negative charge—one electron-charge. And here is a balance on which we can weigh our artificial atoms [shown in Figure 4].[3]

Let us now proceed to build. I put on the balance a proton—a hydrogen nucleus. Now I put on a second proton. This would be a nucleus with weight two and charge two, corresponding to an element of atomic weight 2 and atomic number 2. This does not exist—presumably because there is nothing to hold together the two protons, whose charges repel each other. Suppose now I add an electron, whose negative charge might bind the two positive charges together. This does not change the weight of the nucleus, which is still 2; but its net charge becomes 1, since one proton and one electron neutralize each other (as I may show by covering one proton-disc with the electron, when you see only *one* black area). This atom also does not exist, showing it is not a stable structure. The same is true of the combinations (built up by the speaker) of three protons with one electron and with two electrons. Only when we combine four protons and two electrons do we get an existing atom—that of the element helium. Its nucleus has a weight 4 and a charge 2. Let us compare this with the nucleus with three protons and one electron. The two models look alike to you in the audience, as they would look to the outer electrons, showing they have the same net charge; but the balance proves that they have different weights. Since the remote bodies the two nuclei would exert the same number, namely 2, outer electrons, and on these very remote bodies the two nuclei would exert the same electric force—cause them to arrange themselves and move in the same way; so that the two atoms might be expected to produce substances with the same chemical properties and also the same physical properties, except in the case of properties like density or diffusibility directly dependent on weight or mass.

[3] The speaker is greatly indebted to Dr. Arnold O. Beckman for his assistance in the devising of this demonstration of the structure of atom-nuclei, and to Professor Ira S. Bowen for many helpful suggestions.

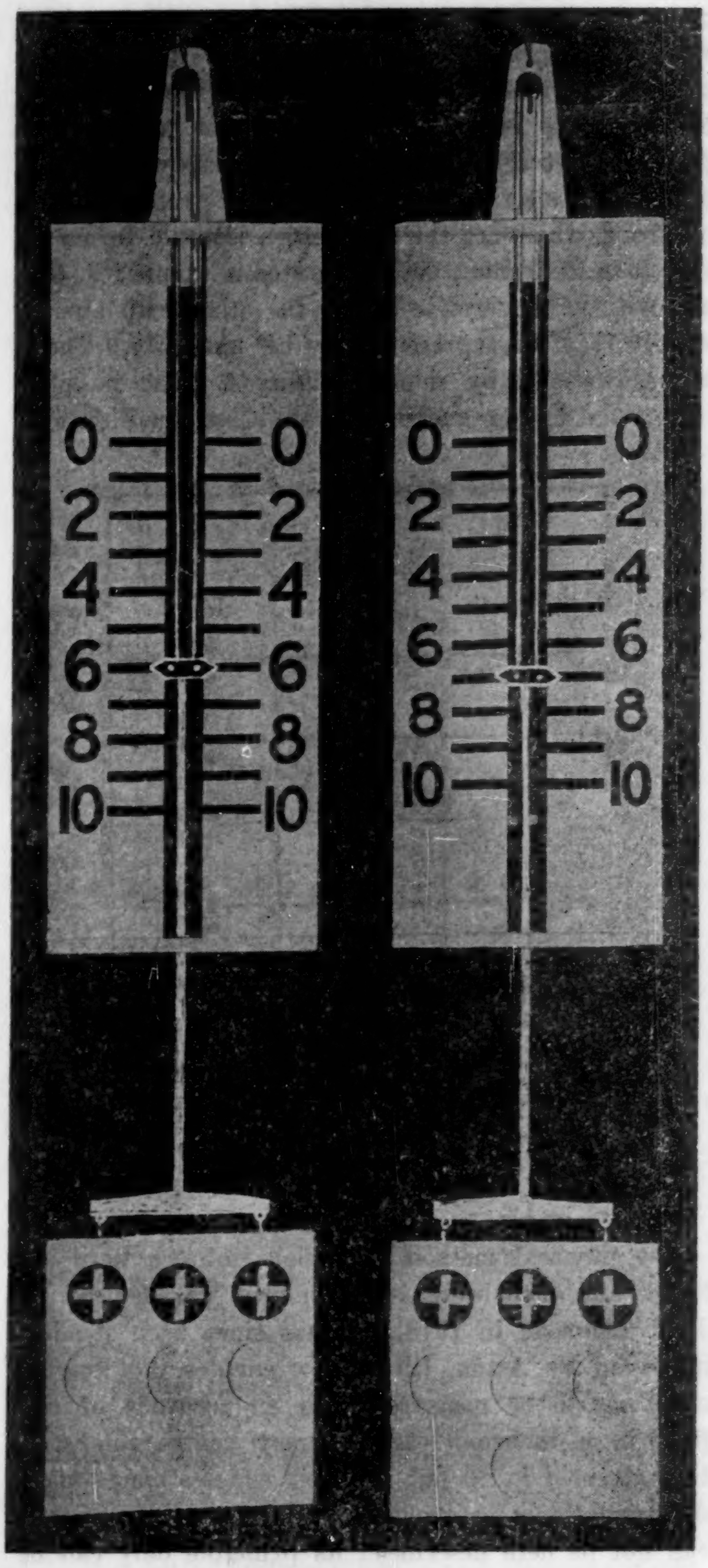

Fig. 4

Atoms of this type, having nuclei with the same charge but with different weights, as well as the almost identical elements which consist of such atoms, are called *isotopes*. Isotopes do not actually exist in the case of helium; but of the next atom, lithium, whose nucleus has three positive charges and whose atomic number is therefore 3, two isotopic forms of weights 6 and 7 have actually been discovered. Let us build up these nuclei by adding protons and electrons to our two helium nuclei in such a way as to

give a nuclear charge of 3. We first get a nucleus with 4 protons and 1 electron, then one with 5 protons and 2 electrons—neither of which exists—probably because there are not enough electrons to bind the protons together. We next get a nucleus with 6 protons and 3 electrons, and one with 7 protons and 4 electrons, which are the two known isotopic forms of the element lithium, both with atomic number 3, but one with atomic weight 6 and the other with atomic weight 7 (often represented by Li^6 and Li^7). These are shown side by side in Figure 4. The possible isotopes of helium and lithium are shown in Figure 5.

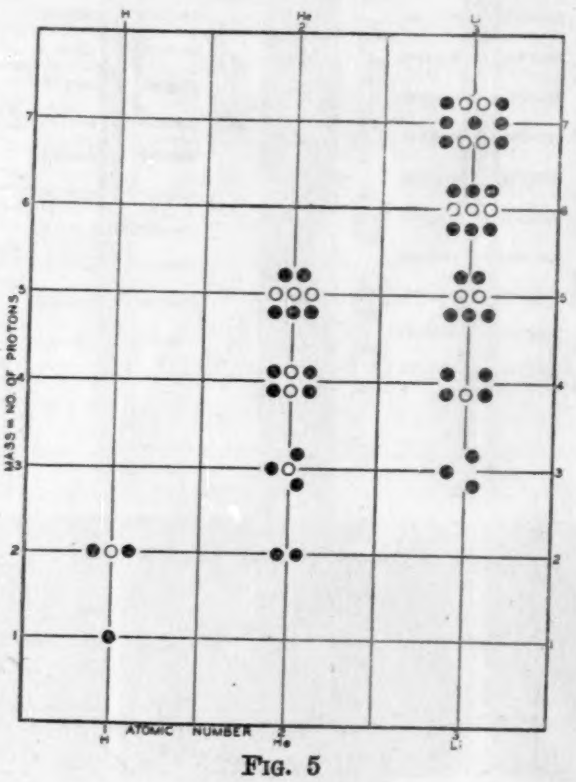

FIG. 5

The physical method by which isotopes were detected and their weights determined was devised by J. J. Thomson in 1913, and has since been steadily improved by Aston, till it now enables the weights of atoms to be measured with an accuracy of one part in a thousand—an accuracy comparable with that attained in all but the most exact atomic-weight determinations by chemical processes. This method can not be here described: its principle only can be briefly indicated. This principle (illustrated by Figure 6) is that a stream of the positive ions of an element, such as is produced in a discharge tube when the ionized atoms of the anode-material or gas shoot through a perforated cathode, on being passed through electric and magnetic fields is deflected from its path to a greater or less extent according as the ions have a smaller or greater mass. This deflection can be derived from the location of the spots produced when the streams of ions strike a photographic plate. The relative proportions of the two or more isotopes can also be estimated from the size and darkness of the spots. In this way lithium is found to give two streams arising from atoms of weights 6 and 7 present in the proportions of 6 and 94.

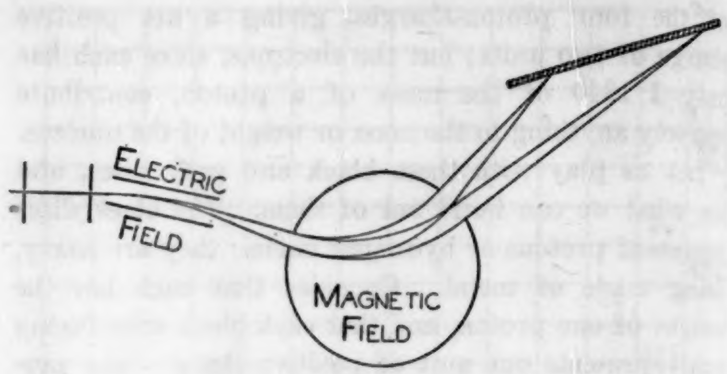

FIG. 6

The results of Aston obtained with the elements up to calcium are shown in Figure 7, the relative pro-

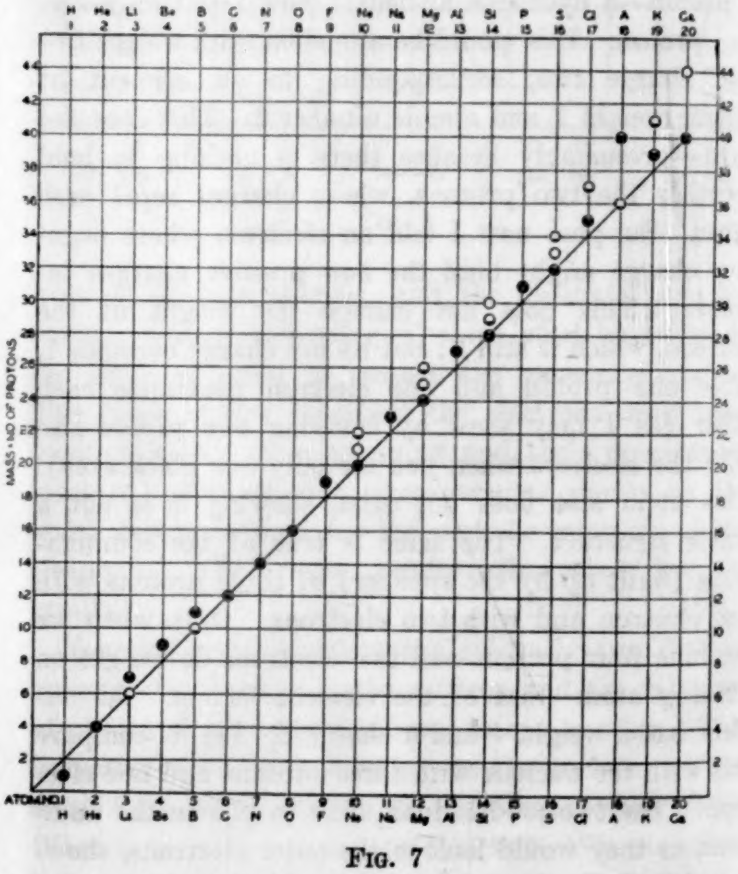

FIG. 7

portions in which two or more isotopes are present being shown by the shading of the circles. The figure shows that only three or four of the elements of the first two periods have isotopes, and that some of these have two and others three isotopes. Some of the higher elements have many more; thus element 34 (selenium) and element 36 (krypton) each have six, and element 50 (tin) has even eleven. On the oblique line crossing the chart any nucleus would be located which contained two protons for each electron. It will be seen that the nuclei of these lower elements mostly conform approximately to this condition.

Let us now consider the bearing of these results on Prout's hypothesis and on the structure of atoms. The accurate results of Aston are shown in Table I.

TABLE I

Atomic No.	Element	Atomic wt.	Isotopes No.	Isotopes At. wt.	Per cent.
1	H	1.0077	1	1.0078	100
2	He	4.00	1	4.0022	100
3	Li	6.94	2	6.012	7
				7.012	93
5	B	10.82	2	10.013	19
				11.011	81
6	C	12.00	1	12.004	100
7	N	14.01	1	14.008	100
8	O	16.00	1	16.000	100
9	F	19.00	1	19.00	100
10	Ne	20.18	2	20.000	91
				22.005	9
15	P	31.03	1	30.982	100
17	Cl	35.46	2	34.983	76
				36.980	24
18	A	39.94	2	35.976	1
				39.971	99
33	As	74.96	1	74.934	100
35	Br	79.92	2	78.929	50
				80.926	50

They prove that the atoms (except hydrogen—to which we will return) have weights that are almost exactly whole numbers when referred to that of oxygen as the whole number 16.00—just as would be predicted if they all were built up out of protons of weight unity and as would be required by Prout's hypothesis assuming the weight of the proton to be equal to that of the nucleus of the hydrogen atom. And the reason that chemically determined atomic weights often are not whole numbers is that many elements are mixtures of two or more isotopes. Thus the fact that chlorine has a "chemical" atomic weight of 35.46 is shown by Aston's results to arise from its being a mixture of about 76 per cent. of atoms of weight 35 and 24 per cent. of atoms of weight 37.

There is, however, apparently one striking discrepancy; the weight of the hydrogen nucleus is not 1.000, but 1.0078 (or ¾ per cent. greater), when referred to oxygen as 16.00. Why then should four protons uniting to form helium give an atom weighing only 4.00, not 4.03? This might have created a serious dilemma, had not Einstein's relativity theory come to the rescue just in time. It is one feature of that theory that energy, like matter, possesses mass, and that escape of energy in large quantity causes an appreciable decrease of mass. Now if a helium nucleus is formed by bringing the positive charges on four protons very closely together with the negative charges on two electrons we can imagine that there would be an enormous liberation of energy; and it may well be this decrease in energy which makes the mass of the helium nucleus three-quarters of a per cent. less than that of four hydrogen nuclei.

The recent very exact measurements of Aston show that a decrease in mass is also observed, though in less degree, in the formation of the higher elements; thus the mass of the oxygen atom is not just four times that of the helium atom, but 0.05 per cent. less than four times. The decreases in mass (expressed in terms of the mass of the hydrogen atom as 1000) derived from Aston's exact mass-spectra measurements are shown in Figure 8. The upper graph shows the

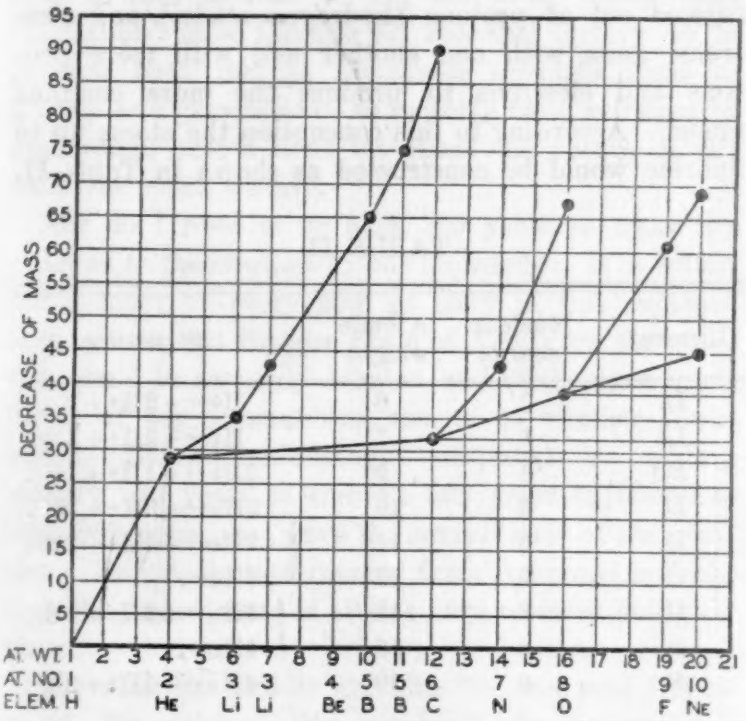

FIG. 8

decrease in mass when the nuclei are considered to be built up successively out of protons and electrons; the lower graphs show the mass-decrease when they are considered to be built up (so far as possible) out of helium nuclei already formed and of protons and electrons.

This decrease in mass is of extraordinary significance in another direction—with reference to the genesis of the elements. It shows that the formation of helium out of hydrogen nuclei and electrons would be attended with an enormous escape of energy. Now, since changes tend to take place in the direction in which energy is evolved, the large energy effects show that there is a great inherent tendency for this synthesis of helium and other atoms of moderate atomic weight to take place. The failure to form under ordinary conditions must be due to unknown dynamic conditions which prevent the nuclei approaching one another closely enough to bring into play the enormous attractive forces which potentially exist. From the view-point of cosmical development

one of the most fundamental questions is, under what conditions, if any, can four hydrogen-nuclei unite with two electrons to form a helium nucleus? And it is this view-point that adds extraordinary interest to the recent conclusion of Millikan and Cameron that some of the cosmic rays have a frequency corresponding to the energy that would be set free in the synthesis of helium from hydrogen; for it indicates that it is now going on somewhere in the universe—a matter which unfortunately we have not time to follow further.

Helium nuclei are probably building stones in the construction of atoms. These nuclei, which are first formed out of protons (hydrogen nuclei) and electrons, unite with one another and with more protons and electrons to produce the more complex nuclei. According to this conception the atoms up to fluorine would be constructed as shown in Table II.

TABLE II

Element	Nuclear charge	Atomic weight	Structure
Li	3	6	$He^{++} + 2H^{+} + E^{-}$.
Li	3	7	$He^{++} + 3H^{+} + 2E^{-}$.
Be	4	9	$2He^{++} + 1H^{+} + 1E^{-}$.
B	5	10	$2He^{++} + 2H^{+} + 1E^{-}$.
B	5	11	$2He^{++} + 3H^{+} + 2E^{-}$.
C	6	12	$3He^{++}$.
N	7	14	$3He^{++} + 2H^{+} + 1E^{-}$.
O	8	16	$4He^{++}$.
F	9	19	$4He^{++} + 3H^{+} + 2E^{-}$.

There are two important lines of evidence that helium nuclei as such are really constituents of atoms. First, Rutherford has found that, when the helium nuclei emitted by radium at high velocity are caused to strike the atoms of certain elements they knock protons out of their atoms, but do not do so out of the atoms of other elements; and what is significant is that among the elements of low atomic weight only those atoms are disrupted which have weights that are not multiples of four; thus helium, carbon and oxygen are not decomposed, but protons are liberated from boron, nitrogen and fluorine; all of which contain protons in excess of those needed to form helium nuclei, as will be seen from Table II. Secondly, the radioactive elements of high atomic weight actually shoot off spontaneously helium nuclei, as we shall soon see.

We turn now to the last sketch in our story, one which must be presented very briefly in the form of a picture. This concerns the disintegration which some elements of high atomic weight are actually undergoing. This discovery opened a new domain of science, which in the first part of this century was developed, in spite of its complexity, with extraordinary rapidity and completeness. It was found that the atoms of certain long-known elements, especially of number 92 (uranium) and 90 (thorium), are shooting out from their nuclei in successive stages in perfectly definite sequence and in definite quantity helium nuclei He^{++} (commonly called alpha particles) as well as electrons (commonly called beta rays). The residual atom thereby progressively decreases in mass and changes in nuclear charge. Remarkably enough we never find that hydrogen nuclei escape.

Figure 9 gives in clear and tolerably complete form

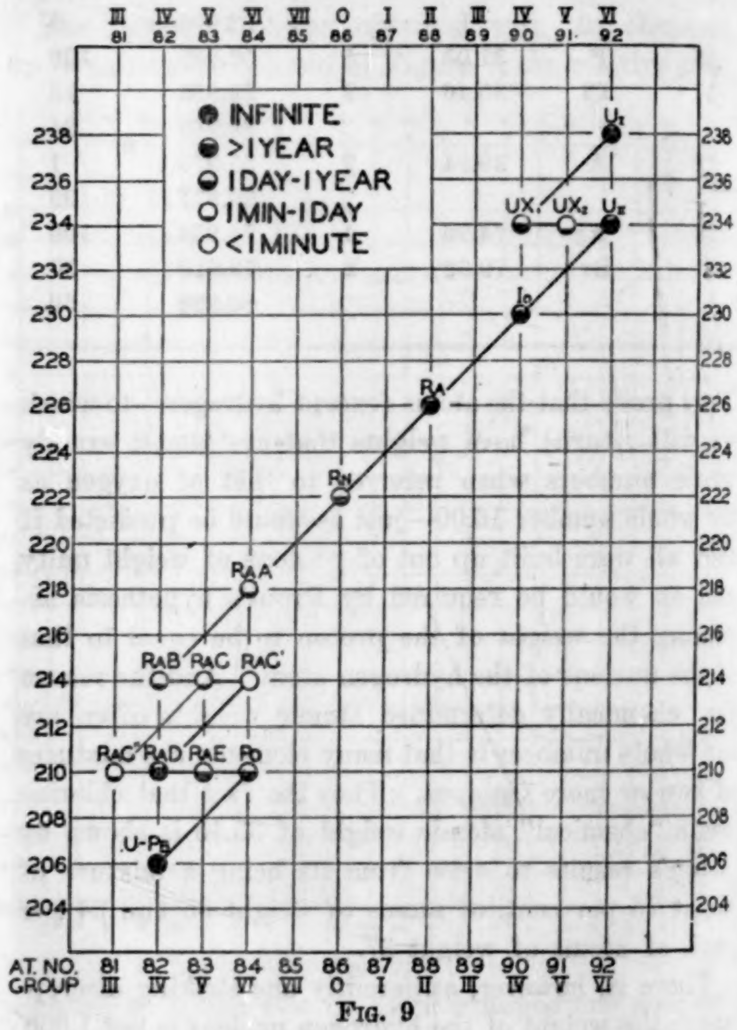

FIG. 9

a survey of the phenomena of radioactive disintegration for one of the three well-known series—the uranium-radium series. In this chart the ordinates represent the atomic weights of the elements, that is, the masses of the atoms; and the abscissas represent the atomic numbers, that is, the nuclear charges, which are equal to the number of the outer electrons and determine their arrangement, and therefore the chemical behavior and most of the physical properties of the elements. The lines indicate the nature of the successive disintegration processes that take place. The lines that run obliquely downward and to the

left obviously show the escape of a helium ion (He^{++}); for this decreases the mass of the nucleus by four, and decreases its positive charge by two units. The lines that run horizontally to the right show the escape of an electron; for this does not change appreciably the mass of the nucleus, but increases its positive charge by one unit. The extent to which the atom is shaded also indicates its stability, which is the inverse of its rate of disintegration. This rate varies enormously: some kinds of atoms having a half-life of billions of years and others of a small fraction of a second, by the half-life being meant that period in which half of the atoms present at the beginning become disintegrated. The five degrees of shading indicate respectively (1) complete stability (no evidence of disintegration); (2) half-lives of more than one year; (3) between a year and a day; (4) between a day and a minute; and (5) less than a minute.

The direct evidence for the series of disintegrations is the nature and velocities of the particles emitted, the velocities being definite and characteristic for each process. But the conclusions are confirmed at several stages by the study of the residual elements. Thus radium was actually separated in a pure state from uranium minerals by the Curies and its atomic weight proved to be that predicted; radon, the immediate product of the disintegration of radium, was shown to be a gas as its position in the periodic system requires, and to be produced in a volume corresponding to the number of helium-ions emitted; and the final product has been isolated from uranium minerals and shown to be a form of lead with an atomic weight of 206, differing from that (207.2) of ordinary lead, which is doubtless a mixture of isotopes.

These radioactive phenomena exhibited by the higher elements thus confirm the conclusions drawn from the studies of the isotopes and of the artificial decomposition of the lower elements that atom-nuclei are built ultimately out of protons and electrons, but with the intermediate formation of helium nuclei, which themselves consist of four protons and two electrons.

This very inadequate survey of our knowledge of the phenomena of isotopes and of the artificial disruption and radioactive disintegration of nuclei in their bearing upon the structure of atoms must now be brought to a close. All that can be hoped is that it has served to give those of you who may be laymen in the field of modern physics some conception of the marvelous development of that science during the present century.

ARTHUR A. NOYES
CALIFORNIA INSTITUTE OF TECHNOLOGY

THE RELATION OF SCIENCE TO INDUSTRY[1]

A WELL-KNOWN public speaker of fifty years ago once remarked ruefully after disastrous consequences had followed misplaced humor, as they often do, "I rose by my gravity and fell by my levity."

I use this incident as an introduction to my speech on "Science and Industry" for the sake of calling attention to the fact that what is absurd or ridiculous to-day was perfectly good science, or at least perfectly good philosophy, not more than 350 years ago—that the very existence of a "law of gravity" was discovered as late as 1650 A. D., and that "levity" and "levitation" have through all recorded history up to Newton been just as acceptable scientific ideas as gravity and gravitation—so recently have we begun to understand just a little bit about the nature of the world in which we live.

Nor do I need to go back 300 years to make my point as to the newness of our knowledge. It is within the memory of every man of sixty in this audience that in the great Empire State of New York the question could be seriously debated, and in the most intelligent of her communities, too, as to whether Archbishop Usher's chronology computed by adding Adam's 930 years to Enoch's 365 years to Methuselah's 969 years, etc., gave the correct date of the creation. Recent election returns from Arkansas indicate that the same debate is at this very moment going on there.

But what has this to do with "Science and Industry"? Everything! For mankind's fundamental beliefs about the nature of the world and his place in it are in the last analysis the great moving forces behind all his activities. Hence the enormous *practical* importance of correct understandings. It is his beliefs about the nature of his world that determine whether man in Africa spends his time and his energies in beating tomtoms to drive away the evil spirits, or in Phoenicia in building a great "burning fiery furnace" to Moloch into which to throw his children as sacrifices to his God, or in Attica in making war on his fellow Greeks because the Delphic Oracle, or the flight of birds, or the appearance of an animal's entrails bids him to do so, or in medieval Europe in preparing for the millennium to the neglect of all his normal activities and duties as he did to the extent of bringing on a world disaster in the year 1000, or whether he spent his energies in burning heretics in Flanders

[1] Address at the 160th annual banquet of the Chamber of Commerce of the State of New York, Waldorf-Astoria, New York City, November 15, 1928.

or drowning witches in Salem, or in making perpetual motion machines in Philadelphia or magnetic belts in Los Angeles, or soothing syrups in New England.

The invention of the airplane and the radio are looked upon by every one as wonderful and preeminently useful achievements, and so they are—perhaps one tenth as useful as some of the discoveries in pure science about which I wish to speak to-night, and hence worthy of at most one or two minutes of a thirty minute speech on the relations of science to industry.

As I listened in Pasadena to the presidential candidates presenting in their own easily recognizable voices from the platform in Madison Square Garden to the people of the United States their claims and the issues of the election, or at least its shibboleths, I found myself aglow with enthusiasm for the future of representative government. The few thousand citizens of Athens gathered about the Acropolis to hear the problems of the city discussed and then to cast their ballots. The 120 million citizens of the United States all had in this recent election precisely the same opportunity and in my judgment they used it judiciously. These public discussions addressed to the *ears* of the nation constitute, I think, a stupendous advance. No such step forward in public education has been taken in my judgment since the invention of printing.

But this new achievement of the race, this new capacity for education was after all only an inevitable incident in the forward sweep of pure science, which means simply knowledge, knowledge of the nature and capacities of the physical world, of the ethereal world (to which the radio belongs), of the biological world and the intellectual world; for this knowledge, as man acquires it, necessarily carries applied science in its wake.

Look for a moment at the historic background out of which these modern marvels, as you call them, the airplane and the radio, have sprung. Neither of them would have been at all possible without 200 years of work in pure science before any bread and butter applications were dreamed of—work beginning in the sixteenth century with Copernicus and Kepler and Galileo, whose discoveries for the first time began to cause mankind to glimpse a nature, or a God, whichever term you prefer, not of caprice and whim as had been all the Gods of the ancient world, but instead a God who rules through law, a nature which can be counted upon and hence is worth knowing and worth carefully studying. This discovery which began to be made about 1600 A. D. I call the supreme discovery of all the ages, for before any application was ever dreamed of, it began to change the whole philosophical and religious outlook of the race, it began to effect a spiritual and an intellectual, not a material revolution—the material revolution came later. This new knowledge was what began at that time to banish the monastic ideal which had led thousands, perhaps millions of men, to withdraw themselves from useful lives. It was this new knowledge that began to inspire man to know his universe so as to be able to live in it more rationally.

As a result of that inspiration there followed 200 years of the pure science involved in the development of the mathematics and of the celestial mechanics necessary merely to understand the movements of the heavenly bodies—useless knowledge to the unthinking, but all constituting an indispensable foundation for the development of the terrestrial mechanics and the industrial civilization which actually followed in the nineteenth century; for the very laws of force and motion essential to the design of all power machines of every sort were completely unknown to the ancient world, completely unknown up to Galileo's time.

Do you practical men fully realize that the airplane was only made possible by the development of the internal combustion engine, and that this in its turn was only made possible by the development of the laws governing all heat engines, the laws of thermodynamics, through the use for the hundred preceding years of the steam engine, and that this was only made possible by the preceding 200 years of work in celestial mechanics, that this was only made possible by the discovery by Galileo and by Newton of the laws of force and motion which have to be utilized in every one of the subsequent developments. That states the relationship of pure science to industry. The one is the child of the other. You may apply any blood test you wish and you will at once establish the relationship. *Pure science begat modern industry.*

In the case of the radio art, the commercial values of which now mount up to the billions of dollars, the parentage is still easier to trace. For if one's vision does not enable him to look back 300 years, even the shortest-sighted of men can scarcely fail to see back as much as eighteen years. For the whole structure of the radio art has been built since 1910 definitely and unquestionably upon researches carried on in the pure science laboratories for 20 years before anyone dreamed that there were immediate commercial applications of these electronic discharges in high vacuum.

It is precisely the same story everywhere in all branches of human progress. I suspect it would be difficult to find one single exception. Here is the latest illustration that came to my attention less than a week ago, in fact just as I was getting aboard the train, in a letter from the Air Reduction Sales Company. It reads as follows: "We take pleasure in handing you herewith a complete set of luminescent tubes, each containing in the pure state one of the ele-

ments of the air, namely, nitrogen, oxygen, argon, hydrogen, neon, helium, krypton and xenon. It seems to us worthy of note that at the beginning of this century these gaseous elements as such had practically no commercial value or significance. To-day the estimated value of the plants and equipment that have been created either to manufacture or to use and handle these gases in industry amounts to three hundred million dollars."

The writer of this letter might have added that the chain of discovery which led up to this result started in the most "useless" of all sciences, astronomy; for helium, as its name implies and as everybody knows, was first discovered in the sun with the aid of the spectroscope, and thirty years later it was its discovery in minute amounts in our atmosphere, also with the aid of the spectroscope, that set us looking for the other inert gases of which the letter speaks and which have recently found such enormous application in neon tubes and the like.

But why continue this recital, for no intelligent man to-day needs to be convinced that our material prosperity rests wholly upon the development of our science. It is as to the broader values, intellectual and spiritual, that even intelligent men sometimes express doubt. Let me then start with the foundations that I have already laid and try to show to what these beginnings are leading, whither we are going, not materially, but as feeling, thinking and willing beings.

Was Pasteur only a scientific enthusiast when he wrote "In our century science is the soul of the prosperity of nations and the living source of all progress. Undoubtedly the tiring discussions of politics seem to be our guide—empty appearances! What really leads us forward is a few scientific discoveries and their application."

Or was H. G. Wells, himself not a scientist at all, merely talking nonsense when he wrote quite recently (and note that he is not talking about a material thing either):

> When the intellectual history of this time comes to be written, nothing, I think, will stand out more strikingly than the empty gulf in quality between the superb and richly fruitful scientific investigations that are going on, and the general thought of other educated sections of the community. I do not mean that scientific men are, as a whole, a class of supermen, dealing and thinking about everything in a way altogether better than the common run of humanity, but in their field they think and work with an intensity, integrity, breadth, a boldness, patience, thoroughness, fruitfulness, excepting only a few artists, which puts their work out of all comparison with any other human activity. In these particular directions the human mind has achieved a new and higher quality of attitude and gesture, a veracity, a self-detachment, and self-abrogating vigor of criticism that tends to spread out and must ultimately spread to every other human affair.

These may be extravagant statements, most of us scientists are sure they are, but I should like to attempt to picture a little of what I think was in the back of the minds of their authors when they made those statements. I shall do it by drawing an analogy between the life of mankind as a whole and the life of man as an individual. But first let me answer the question as to what we know about the duration of the life of mankind. A hundred years ago we knew practically nothing about it, as my opening remarks on Archbishop Usher's chronology showed. But since then we have made some scientific discoveries—discoveries that are not usually listed as of industrial importance at all, but which in my opinion outweigh by far, in practical value to the race, either the invention of the airplane or of the radio, and that simply because they change fundamentally our ideas about the nature of the outside world, and hence change also the nature of our acting in relation to it.

We have learned within the past half dozen years through studies in radio activity that this world of ours has in all probability been a going concern, in something like its present geological aspects as to crustal constituents, temperatures, etc., for more than a billion years, and hence that the human race can probably count on occupying it for a very long time to come, say another billion years; and further, that mankind has been doing business on it in something like his present shape for something like 20,000 years, or possibly 50,000, but in any case a time that is negligibly small in comparison with the time that is behind and the time that is presumably ahead of him—in other words, we have learned that mankind, speaking of him as an individual human being, is now just an infant a few months old at the most, an infant that up to about one minute ago, for the 300 years since Galileo is but a minute in the geological time-scale, has been lying in his crib spending his waking hours playing with his fingers, wiggling his toes, shaking his rattle, in a word, in simply becoming conscious of his own sensations and his functions, waking up, as he did amazingly in Greece, to his own mental and emotional insides. Just one minute ago he began for the first time to peer out through the slats in his crib, to wonder and to begin to try to find out what kind of an external world it is that lies around him, what kind of a world it is in which he has got to live for the next billion years. The answers to that question, even though never completely given, are henceforth his one supreme concern. In this minute of experience that he has already had he has

tumbled down in his crib, bumped his head against the slats, and seen stars—real ones and unreal ones, and he hasn't yet learned to distinguish with certainty between those that actually exist and those that only seem to exist because his eye-balls have been subjected to the pressure that comes from a blow, and so he is reaching out his hands part of the time trying to grasp illusions, and yet slowly, painfully learning, bit by bit, that there is an external world, physical and biological, that can be known, that can be counted upon, when it has once become known, to act consistently, not capriciously, that there is a *law* of gravity and that it isn't necessary to be covered with bruises all the time because he forgets that it exists, that there is a principle of conservation of energy, and that all constructive and worth while effort everywhere must henceforth take it into account and be consonant with it, that it is not worth while to spend much time hereafter with sentimentalists who wish that that law did not exist and sometimes try to legislate it out of existence, that again there are facts of heredity that it is utterly futile to inveigh against, that our whole duty is rather to bend every energy to know what they are and then to find how to best live in conformity with them, that in a single sentence there is the possibility ahead of mankind of learning, in the next billion years of its existence, to live at least a million times more wisely than we now live. This is what Pasteur meant when he said, "What really leads us forward is a few scientific discoveries and their applications." This is what Wells meant when he contrasted the result of the objective method of learning used in the pursuit of science with what he calls "the general thought of other educated sections of the community." The one guesses and acts upon its hunches or its prejudices, the other tries at least to know, and succeeds in knowing part of the time.

We need science in education, and much more of it than we now have, not primarily to train technicians for the industries which demand them, though that may be important, but much more to give everybody a little glimpse of the scientific mode of approach to life's problems, to give every one some familiarity with at least one field in which the distinction between correct and incorrect or right and wrong is not always blurred and uncertain, to let him see that it is not true that "one opinion is as good as another," to let every one understand that up to Galileo's time it was reputable science to talk about gravity and levity, but that after Galileo's time the use of levity became limited to the ridiculous, that "the town that voted the earth was flat, flat as my hat, flatter than that," had a perfect right to exist before 1400 A.D., but not after that date, that we are learning slowly through the accumulated experience and experimenting of the centuries, especially since 1600 A.D., more about the eternal laws that do govern in the world in which we live. And for my own part I do not believe for a moment that these eternal laws are limited to the physical world either. Less than sixty years ago, to take one single illustration, there existed a relatively large political party in the United States called the Greenback Party which jumped at conclusions and which conducted campaigns to induce our government to go over to a fiat money basis. I do not suppose such a party could exist to-day unless it be in states that pass anti-evolution laws, for there are some laws that *have become established*, even in the field of finance.

This brings me to a brief discussion of the current opposition to the advance of science—an opposition participated in even by some intelligent people, on the ground that mankind can not be trusted with too much knowledge, by others on the ground that beauty and art and high emotion are incompatible with science. Now, fear of knowledge is as old as the Garden of Eden and as recent as Dr. Faust, and there is no new answer to be made to it. The old answer is merely to point to what the increase in knowledge has done to the lot of mankind in the past, and I think that answer is sufficient, for it has certainly enfranchised the slave, and given every man, even the poorest, such opportunities as not even the prince of old enjoyed. Who would go back to the stone age because stone age man had no explosives? Of course every new capacity for beauty and joy brings with it the possibility of misuse and hence a new capacity for sorrow. But it is our knowledge alone that makes us men instead of lizards, and thank God, we can not go back whether we would or no. Our supreme, our God-like task, is to create greater beauty and fuller joy with every increased power rather than to turn our weeping eyes toward the past and fling ourselves madly, unreasoningly athwart the path of progress. Beauty in the amoeba's house disappeared when man cleaned up the miasmic swamp, but it was only because the amoeba had not the capacity to adapt itself to modern sanitation.

No, the only real question in a nation like ours is not whether science is good for us materially, intellectually, esthetically, artistically. Of course it is, for science is simply knowledge and all knowledge helps. The only real question is how the forward march of pure science, and of applied science which necessarily follows upon the heels, can best be maintained and stimulated, for, as Pasteur said, "It is this alone that really leads us forward."

The answer to that question will depend upon the nature of one's whole social philosophy. If you think

that social progress is best brought about by a paternalistic régime of some kind, by throwing upon a few elected or hereditary officials the whole responsibility for social initiative of all sorts, then you will say, "Let the government do it all; let it establish state universities and state research laboratories and state experimental projects of all kinds as it has done in most European countries and let the whole responsibility for our scientific progress lie in these institutions." But if you believe with the early makers of our nation in the widest possible *distribution* of social responsibility, in the *wide-spread* stimulation of constructive effort, in the nearest possible approach to equality of *opportunity*, not only for rising to wealth and position, but for sharing in community service, if you believe with the President-elect that government should only step in where private enterprise fails, that it should act only as a *stimulant* to *private initiative* and a *check to private greed*, then your industries in the New York Chamber of Commerce, your industries which are themselves the offspring of pure science, will join in the great nation-wide movement to keep alive the spirit of science all over this land of ours through keeping pure science going strong in the universities its logical home, and applied science going strong in the private industrial laboratories where it thrives best. No country ever had such an opportunity as ours, no country ever had such a widespread stimulation of individual initiative, such a large number of citizens who had learned to treat financial power as a public trust, such resources to command, such results to anticipate. With our American ideals American industry can not fail, I think, to realize this opportunity, and to support and keep in the finest possible condition, "the hen that lays her golden egg." That is my conception of the relation of science to industry in the United States.

Robert A. Millikan

California Institute of Technology

WILLIAM NORTH RICE

1845–1928

William North Rice died November 13 at the home of his son, Professor Edward L. Rice, in Delaware, Ohio, 8 days before his 83d birthday. Two days before, on Sunday, he had attended church service, taken his usual walk, and was in excellent spirits.

Professor Rice, a thoroughly trained classical scholar, was the youngest member and valedictorian of the class of 1865 at Wesleyan University. In 1867 he received his doctor of philosophy degree from Sheffield Scientific School (Yale). He was immediately appointed professor of geology and natural history in Wesleyan and after a year of study in Germany commenced what proved to be a lifetime of service at his *alma mater*. In 1884 the work which he had been carrying was divided and he continued as professor of geology until 1918, when he retired as professor of geology, emeritus.

Professor Rice was first and always a teacher, and his chief monument will always be the affectionate memory of the students who for fifty years sat under his clear, accurate and inspiring instruction. Nor was his influence in educational matters confined to the classroom. At Wesleyan, perhaps more than in most colleges, the faculty determines the college policies. Between 1870 and 1920 the three outstanding faculty names at Wesleyan were VanVleck, Winchester and Rice: each was a great teacher and each exerted a large influence on the development of the college. No one of the three was more responsible for the educational evolution of Wesleyan than Professor Rice, though he himself would doubtless make an exception of VanVleck. For ten years he was secretary of the faculty and three times served as acting president.

Professor Rice was an ordained minister of the Methodist Church and while he never held a regular pastoral charge was an occasional and effective preacher through life. This double interest in religion and in teaching led him naturally into what is perhaps the most outstanding activity of his life, his study of and writings on the relations of science and religion. In the early seventies he had accepted the evolution theory—the *Origin of Species* was a new book in 1865—and during the following years at Wesleyan both in his college classes and in his Sunday afternoon Bible class he was ever intent on helping the student to meet and accept the new scientific knowledge without loss of religious faith. Wesleyan students in those days who came under his influence were not troubled by evolution or Old Testament criticism. Out of this work came his best known and most important book, *Christian Faith in an Age of Science*. There were fundamentalists even in those days and when it was necessary to meet them outside college walls Professor Rice, who was a brilliant debater, never came off second best. A recent clash with John Roach Straton gave him especial joy, and when Straton began to quote Price's *The New Geology* his comment was, "Now hath the Lord delivered him into my hands." He used to say of himself—"I must be orthodox for have I not for years been Chairman of the Committee of the N. Y. East Conference of the Methodist Church which has to pass on the orthodoxy of candidates for the Methodist ministry!"

Professor Rice's geological field work, though it includes a report of the *Geology of Bermuda*, was mostly done on the geology of Connecticut. He was asked to revise Dana's *Text-book of Geology* for the fifth edition. From 1903–16 he was Superintendent of the Connecticut State Geological and Natural History Survey and in addition to seeing the various bulletins through the press wrote (with H. E. Gregory) a *Manual of the Geology of Connecticut*. It was for the same Survey that last year he wrote, with W. G. Foye, a *Guide to the Geology of Middletown*. Professor Rice's knowledge of botany, zoology, and geology was wide and accurate. If his original production in geology is less than that of many of his geological contemporaries it should be remembered that for the first sixteen years of his teaching he taught botany and zoology as well as geology, and that more and more in later years his interest was growing in the relations of science and religion. He himself considered that it was in this field that he had done his best and most useful work. He often said that he "would have done more if he hadn't tried to do so much"—and another might add, "and to do it so well."

No account of Professor Rice can be at all satisfactory that does not put first the man, his mental and spiritual traits, rather than the work done; and yet how hard it is to do this adequately! He was small of stature and slight of build; and while not at home in rough outdoor exercise could outwalk most of his students. Perhaps one's first impression of him might be one of seriousness and logical perfection of mental processes. He spoke when he had something to say and while he enjoyed a joke as well as any did not easily make small talk. He had the patience and conscience to make sure of his facts; few caught him napping here. And he had a mind fundamentally orderly and logical. Home training, education and inclination made him a wide and thorough reader, especially in history and the best English prose and poetry, though he was not interested in technical philosophy. His favorite poets were Tennyson and Whittier and one of his published essays was on *Tennyson, the Poet of Science*. Perhaps it was his classical training that gave him his mastery of the niceties of the English language. He read his New Testament in the original Greek throughout life.

Keenness of intellect in Professor Rice was balanced by the depth and intensity of his ethical and religious life. He was a *fair* man, carrying over into every field of his thought the scientific attitude of mind. Everything was seen against a background of moral and religious values and took meaning from that background. His love of beauty in nature was profound—whether on walking tours in the Alps, or along the shores and in the woods and fields of New England. This last fall in central Ohio he was out almost every afternoon and his joy in the colors of autumn foliage and sunset sky was intense. And to him it was always God's world.

His interest in community educational and religious matters was constant. For some time he was president of the Middletown school board. In recent years he has been a member of the Council of the Connecticut Federation of Churches, twice its president and for a long time its secretary. He has always been interested in temperance and on that ground, among others, was an ardent Hoover man during this last election. When he finally decided not to attempt to go back to Middletown to vote, he made partial amends by sending liberal contributions to the Connecticut State and local Republican Committees and to the Anti-Saloon League.

Professor Rice was a member of the American Society of Naturalists (president in 1891), of the Geological Society of America (vice-president, 1911), and of the American Association for the Advancement of Science (vice-president and chairman of Section E, 1905–6). It was a source of regret to him that in the multiplication of organizations in recent decades and the separation of their meetings in time and place from those of the parent society, the American Association, with its emphasis on the common work of science as a whole, should suffer.

L. G. WESTGATE

SCIENTIFIC EVENTS

PALEOLITHIC DISCOVERIES IN NORTHERN IRAQ

THE British-American Archeological Expedition in northern Iraq, which is the joint undertaking of the Percy Sladen Fund (British) and the American School of Prehistoric Research, has just closed a most successful season. Miss Dorothy A. E. Garrod, leader of the expedition, has reported to Dr. George Grant MacCurdy, director of the American School of Prehistoric Research, the finding of numerous caves northeast of Bagdad in the region of Sulaimani.

The complete excavation of one cave at Larzi has yielded important results proving that the prehistoric race which lived on the eastern tributaries of the Tigris River during the latter part of the Old Stone Age had a culture practically identical with that of the race living at the same time in central and western Europe—a culture known as Aurignacian, left by the race of Cro-Magnon.

The industrial remains at Larzi are not only typically Aurignacian but also very numerous. The flint

implements are exactly comparable with those from south central France and the Danube valley in Austria; they do not, however, seem to have any close affinities with the contemporary Capsian industry of northern Africa. Another feature is that, near the top of the deposit, the industry grades off into the Mesolithic or Tardenoisian microlithic industry, without passing through the European intermediate stage of the Paleolithic known as Solutrean and Magdalenian.

Through a cable dispatch just received, Dr. MacCurdy is also able to announce that the expedition has explored and partly excavated a great cave that was inhabited by the more primitive and much earlier Neandertal race. The flint implements are like those from the Mousterian caves of central and western Europe. The discoveries in northern Iraq are said to throw much new light on the unity and continuity of Old Stone Age cultures and races so far as both Europe and Asia are concerned and Dr. MacCurdy hopes that they may eventually help to elucidate the problem as to whether the prehistoric current was from east to west or the reverse.

THE HEALTH COMMITTEE OF THE LEAGUE OF NATIONS

THE thirteenth session of the Health Committee of the League of Nations was held at Geneva, October 24–31. According to the report of the meeting in the *Journal* of the American Medical Association the only American member present was Dr. Alice Hamilton, assistant professor of industrial medicine, Harvard School of Public Health, Boston. The committee's first work was the adoption of the June report of the malaria commission. The commission emphasized the necessity of acquiring a wider knowledge of malaria and of the parasite of the mosquito, and suggested that each government establish a central permanent organization of workers who would devote their whole time to malaria research. It suggested some general rules for combatting malaria and proposed a number of subjects for research on its epidemiology and a program of research on the use of cinchona alkaloids and on housing in relation to malaria. The health committee of the League of Nations in October adopted plans to organize an international leprosy inquiry, a national center for which has already been set up in Brazil. The reports of the smallpox and cancer commissions were adopted. The subcommittee of experts of the latter commission, which is studying the radiotherapy of cancer, hopes to report soon on the results of radiologic treatment in three important institutions, those at Munich, Paris and Stockholm. The committee decided to place at the disposal of the International Ophthalmological Society the documentation collected on the subject of the protection of the blind and on trachoma. The committee heard a report on the dengue epidemic in Greece from Dr. W. D. MacKenzie, who had been sent to Greece at the request of the government. The committee authorized its president, Dr. Madsen, Denmark, to name four members to a commission for the revision of the nomenclature of the causes of deaths. The question which provoked the longest discussion before the committee was the request of the council that the health organization of the League of Nations should collect full statistical information regarding alcoholism, giving prominence, according to the data available, to the deleterious effects of the bad quality of the alcohols consumed. As a result of the discussion, it was decided to ask the health services of Finland, Poland and Sweden, which had presented the resolution concerning alcohol to the assembly of the League of Nations, to state what were the particular problems of public health on which they desired international collaboration. During this session of the health committee, for the first time, moving pictures on different aspects of its work were shown. One film was on rural hygiene in India, and another on the Copenhagen Conference of Experts on the Sero-Diagnosis of Syphilis.

FELLOWSHIPS IN MEDICINE OF THE NATIONAL RESEARCH COUNCIL

THE following fellows in medicine of the National Research Council, appointed at the April and September meetings of the Medical Fellowship Board, have begun their fellowship work for the year 1928–29:

Leon H. Collins, Jr., biochemistry and pathology.
P. Arthur Delaney, pathology.
Henry H. Dixon, neurology.
Simon Dworkin, physiology.
Lawrence S. Kubie, neurology and psychiatry.
Stephen J. Maddock, experimental surgery.
Kenneth I. Melville, pharmacology (chemotherapy).
Valy Menkin, physiology.
David McK. Rioch, neuro-physiology.
Herbert L. Ratcliffe, parasitology.
Matthew C. Riddle, diseases of the blood.
Harold G. Wolff, neurology (experimental).
Charles Eugene Woodruff, pathology.

Those whose terms of fellowship have expired during the summer have received the following appointments:

William C. Austin, Ph.D., professor, department of physiological chemistry, Loyola University School of Medicine, Chicago.

Walter Bauer, M.D., instructor and tutor in internal medicine, Harvard Medical School and Massachusetts General Hospital.

Martin H. Dawson, M.D., assistant, department of bacteriology, Hospital of the Rockefeller Institute, New York City.

Peter Heinbecker, M.D., instructor in surgery, Washington University School of Medicine, Saint Louis.

Francis F. Heyroth, M.D., department of internal medicine, University of Cincinnati.

T. Duckett Jones, M.D., resident, department of medicine, House of the Good Samaritan, and assistant in medicine, Harvard Medical School, Massachusetts General Hospital.

Ralph G. Smith, M.B., instructor, department of materia medica and therapeutics, University of Michigan.

Lester R. Whitaker, M.D., assistant in anatomy and surgery, Boston University School of Medicine.

Richard W. Whitehead, M.D., associate professor of physiology and pharmacology, University of Colorado, Denver.

Edgar F. Fincher, Jr., M.D., has received a fellowship (neurology) at Mayo Clinic, Rochester, Minnesota.

Willard O. Thompson, M.D., has received the Henry P. Walcott fellowship in medicine, Harvard Medical School and Massachusetts General Hospital.

G. CARL HUBER,
Chairman, Medical Fellowship Board,
National Research Council

THE YALE SCHOOL OF MEDICINE AND THE NEW HAVEN HOSPITAL

THE formal opening of the new laboratory building for the joint use of the Yale School of Medicine and the New Haven Hospital took place on January 3. On the following day the laboratories and their equipment were thrown open to the public. The building, which was made possible by a grant of $1,250,000 to Yale University from the General Education Board of New York City, provides for the New Haven Hospital eight operating rooms for ward patients, a completely equipped accident ward, suites of examining rooms for surgery and urology, gynecology and orthopedics, and complete therapeutic facilities for the treatment of orthopedic patients. For the School of Medicine there are adequate quarters for research and teaching in surgery, obstetrics and gynecology, pathology, bacteriology and immunology, nursing and public health.

Connected directly with the existing wards and administrative offices of the hospital the new laboratories represent a further step in the formation of a medical unit, composed of the New Haven Hospital, the New Haven Dispensary, the Yale School of Medicine and the Yale School of Nursing for the care of the sick, the education of men and women in medicine and its allied fields and the advancement of medical research.

The scheme of the building is said to be unique in that it aims to provide for each member of the full-time staff of the hospital and for each member of the faculty of the School of Medicine a unit consisting of administrative offices, private laboratory, examining and treatment rooms for his particular branch of medicine and student laboratories and classrooms.

The building is constructed in the shape of a U, enclosing on three sides an area equal to half a city block. Each of the three wings is about 200 feet long and 50 feet wide, with a corridor running through the center, so that all rooms have outside exposure. The east and west wings are four stories and basement in height, the south wing three stories and basement. Each wing is named in recognition of a major benefaction to the hospital and school, the east wing, on Cedar Street, being known as the Anthony N. Brady Memorial Laboratory; the south wing, Lauder Hall, and the west wing the Farnam Memorial Building.

A feature of the teaching facilities is a group of twelve small laboratories to each of which six students are assigned for the year. The student has a key to his room and may use it day or night. Two amphitheaters each seating 140 are provided for general lectures and clinics. Small lecture rooms, special laboratories and work rooms for students are also contained in each of the departments represented in the building. Dormitories are provided in the basement of Farnam Memorial Building for internes on call in the accident and obstetrical wards, and living quarters for ten resident doctors are located on the fourth floor of Brady Laboratory.

The new laboratories constitute the fifth unit of the Hospital and Medical School Group to be completed within the last ten years. The Sterling Hall of Medicine, containing the administrative offices, auditorium, library and teaching and laboratory facilities for anatomy, physiology, physiological chemistry, pharmacology and toxicology, was completed in 1923 at a cost of $2,100,000, including the power house for the group. The Private Patient Pavilion, costing $437,000, was erected in the same year. The first unit of the Anthony N. Brady Memorial Laboratory was built in 1927 at a cost of $167,000. The Boardman Administration building of the hospital was completed at a cost of $183,000 in 1928.

It is planned in the near future to erect a 100-bed ward for medicine and pediatrics, made possible through the gift of $1,000,000 made to Yale University last spring by A. E. Fitkin, of New York City.

THE ROCKEFELLER FOUNDATION

THE Rockefeller Foundation and the Laura Spelman Rockefeller Memorial have been consolidated by an order of the courts granting the joint petition. The consolidated organization, to be known as the

Rockefeller Foundation, will take over the social science program of the Laura Spelman Rockefeller Memorial, while a new corporation to be known as the Spelman Fund of New York with an endowment of $2,500,000 has been created to carry on the work heretofore done by the memorial in the advancement and diffusion of knowledge concerning child life, the improvement of inter-racial relations and cooperation with public agencies. The General Education Board is not included in the consolidation.

The Rockefeller Foundation, "to promote the well-being of mankind throughout the world" was established with a fund of $100,000,000 contributed by Mr. John D. Rockefeller, who, in 1917, made a gift of an additional $25,000,000. At various times since then Mr. Rockefeller has made other large gifts to the institution. The Laura Spelman Rockefeller Memorial, bearing the name of the late Mrs. John D. Rockefeller, was founded in 1918.

Dr. George E. Vincent, president of the Rockefeller Foundation, will be president of the consolidated organization.

Since the establishment of the Rockefeller Foundation, the General Education Board, the Laura Spelman Rockefeller Memorial and the International Education Board, their trustees have distributed from capital funds a total of $225,000,000 not including appropriations from income.

The combined book value of capital funds of the new Rockefeller Foundation is given as $214,282,546, of which $35,000,000 is set aside to provide for outstanding appropriations and obligations. This leaves a net capital based on book values of $158,000,000.

But while the book value of the stocks and bonds of the Foundation was set forth as having a value of $98,811,080 and $28,791,100, respectively, the market values of stocks are given as $163,803,476, and of the bonds, $29,773,747. The income for 1928 was $9,175,550.

The book value of the stocks and bonds of the Laura Spelman Rockefeller Memorial are given as $17,950,742 and $38,332,806, respectively, the stocks having a market value of $35,744,838, and bonds, $44,519,189. The income for 1928 was $4,693,609. The foundation has other assets amounting to $30,055,408, and its land, buildings, equipment and supplies are valued at $422,973. Other assets of the Memorial are $8,843,986.

The directors and trustees of the new Rockefeller Foundation are James R. Angell, Trevor Arnett, John W. Davis, David L. Edsall, Simon Flexner, Raymond B. Fosdick, Jerome D. Greene, Ernest M. Hopkins, Charles P. Howland, Vernon Kellogg, John D. Rockefeller, Jr., William Allen White, Ray Lyman Wilbur, Arthur Woods, Owen D. Young, Julius Rosenwald, Anson Phelps Stokes, Frederick Strauss, Augustus Trowbridge and George H. Whipple.

The officers are John D. Rockefeller, Jr., chairman of the board of trustees; Dr. George E. Vincent, president; Roger S. Greene, vice-president for the Far East; Selskar M. Gunn, vice-president for Europe; Edmund E. Day, director for the social sciences; Max Mason, director for natural sciences; Dr. Richard M. Pearce, director for medical sciences; Dr. Frederick F. Russell, director of the international health division; Norma S. Thompson, secretary; Louis Guerineau Myers, treasurer, and George J. Beal, comptroller.

The officers of the board of the Spelman Fund are Arthur Woods, chairman; Beardsley Ruml, executive secretary; Revell McCallum, secretary, and Louis Guerineau Myers, treasurer. Other members are Winthrop W. Aldrich, Cleveland E. Dodge, Raymond B. Fosdick and Thomas W. Lamont.

The officers of the General Education Board are Trevor Arnett, president; Charles R. Richards, director for industrial arts; William W. Brierley, secretary, and Louis Guerineau Myers, treasurer. Other members of the board are James R. Angell, James H. Dillard, Raymond B. Fosdick, Jerome D. Greene, Charles P. Howland, John D. Rockefeller, Jr., Albert Shaw, Anson Phelps Stokes and Dr. George E. Vincent.

SCIENTIFIC NOTES AND NEWS

DR. OLIVER KAMM, head of the department of chemical research of Parke, Davis and Company, formerly professor of organic chemistry in the University of Illinois, has been awarded the prize of $1,000 of the American Association for the Advancement of Science. The prize is awarded each year for a notable contribution to science presented at the annual meeting of the association and the associated scientific societies. Dr. Kamm's paper, presented before the section of chemistry, was entitled "Hormones from the Pituitary Glands."

THE Nichols medal of the New York section of the American Chemical Society, for "the research published during the current year which in the opinion of the jury is most original and stimulative to further research," has been awarded to Professor William Lloyd Evans, chairman of the department of chemistry of the Ohio State University, for his contributions to the chemistry of carbohydrates. The medal will be formally conferred upon Professor Evans at a national gathering of chemists in Rumford Hall, New York, on March 1, when he will deliver an address on "The Mechanism of Carbohydrate Oxidation."

The council of the Physical Society of London has awarded the Duddell Memorial medal for 1928 to Dr. Charles Edouard Guillaume, director of the International Bureau of Weights and Measures at Sèvres, France, and winner of the Nobel prize in physics for 1920. The medal is awarded annually to the inventor of new scientific instruments or of discoveries of new materials used in their construction.

Dr. J. Russell Smith, professor of economic geography at Columbia University, is the recipient of the medal of the Harmon Foundation awarded to the "author of an article of signal benefit in stimulating constructive opinion in social or economic fields." The award consists of a gold medal and $500 in cash. The award to Dr. Smith was based on his article, "Plan or Perish," published in the *Survey Graphic* in July, 1927, in which he discussed the situation in the Mississippi Valley leading up to the flood disaster and offered a plan for the control of a great river at high water.

Professor Francis H. Herrick was given a dinner on December 1 commemorating the "fortieth year of his service to Western Reserve University and the fortieth anniversary of the establishment of the department of biology." Some one hundred of his colleagues joined in honoring him on this occasion and brief addresses were given by the president, Dr. Robert E. Vinson, representing the university; by Harold Clark, representing the Cleveland Museum of Natural History, and by Dr. Henry B. Ward, representing the biologists of the country. To these addresses Professor Herrick responded.

Senator Bruce has introduced a bill in the United States Senate which would authorize Drs. William S. Thayer and William H. Welch, Baltimore, "to accept such decorations, orders and medals as have been tendered them by foreign governments." Dr. Welch and Dr. Thayer are members of the medical reserve corps of the army, and congressional authority is necessary before they can accept foreign decorations.

Dr. William D. Coolidge and Dr. Irving Langmuir have been appointed associate directors, and Dr. Albert W. Hull and Dr. Saul Dushman have been appointed assistant directors, of the Research Laboratory of the General Electric Company at Schenectady, New York.

Major James Stevens Simmons, M. C., U. S. Army, formerly in charge of the bacteriological department and assistant director of laboratories at the Army Medical School, Washington, D. C., has been transferred to the Philippine Islands and appointed president of the U. S. Army medical department research board, in the Bureau of Science, Manila, P. I.

At the last meeting of the executive committee of the board of trustees of the Colorado Museum of Natural History, Denver, the following changes in the staff were made: Harold J. Cook, of Agate, Nebraska, who has been honorary curator of the department of paleontology, has been made active curator; Robert J. Niedrach, long associated with the museum in various capacities, has been placed in charge of the department of ornithology, and will proceed with preparation of the materials secured by the last two South American expeditions, soon to be placed on exhibition in the new South American wing.

New York University has granted the request of The American Society of Mechanical Engineers that Major Carlos de Zafra, a member of the engineering faculty of the university, be given leave of absence for one year to devote full time to the direction of the *Engineering Index Service*. This service, operated without profit to the society, reviews approximately 1,700 technical publications in 17 languages from 37 countries and issues annotations in card index form. Over 42,000 index cards involving over 100,000 references in all branches of engineering were issued in 1928.

Dr. Adolf Hoel, of the University of Oslo, has accepted an invitation of the Italian government to join an official commission which will investigate the *Italia* tragedy of last summer. Captain Einar Lundborg, the Swedish aviator who reached General Nobile, also has been invited to testify at the Italian inquiry.

As already reported in Science, Dr. Irving Langmuir has been elected president of the American Chemical Society. Other officers elected were: director from the second district, Wilder D. Bancroft; director from the fifth district, Frank C. Whitmore; councillors at large, E. M. Billings, H. S. Taylor, E. R. Weidlein and M. C. Whitaker.

At the meetings of the American Psychological Association held at Columbia University, New York City, on December 27, 28 and 29, the following elections were announced: President, Dr. K. S. Lashley, Institute for Juvenile Research, Chicago, Illinois; secretary, 1929–1931, Professor Carl C. Brigham, Princeton University; representatives on the division of anthropology and psychology, National Research Council, Professor Samuel W. Fernberger, University of Pennsylvania, and Professor Walter Miles, Stanford University; representative on the Social Science Research Council, Professor Floyd H. Allport, Syracuse University; representative on the council of the American Association for the Advancement of Sci-

ence, Dr. Walter V. Bingham, Personnel Research Federation, New York City, and Professor Robert M. Ogden, Cornell University. At the business meeting of the association it was voted to omit the usual annual meeting in December, 1929, and merge this with the meeting of the Ninth International Congress of Psychology to be held at Yale University in September under the presidency of Dr. J. McKeen Cattell. The presidential address of Dr. Lashley will be given at that time.

DR. HENRY CREW, professor of physics at Northwestern University, was elected president of the American Association of University Professors at the recent New York meeting. Professor H. C. Warren, of Princeton University, was elected vice-president to succeed Marion P. Whitney, of Vassar College. The following officers were reelected: Professor H. W. Tyler, of the Massachusetts Institute of Technology, *secretary*, and Professor Joseph Mayer, of Tufts College, *treasurer*. New members of the council were elected as follows: B. H. Bode, of the Ohio State University; A. L. Bondurant, of the University of Mississippi; M. T. Bogert, of Columbia University; H. S. Conard, of Grinnell College; H. G. Doyle, of George Washington University; P. O. Ray, of the University of California; F. K. Richtmyer, of Cornell University; Joseph Stebbins, of the University of Wisconsin; H. S. White, of Vassar College, and H. V. Wilson, of the University of North Carolina.

OFFICERS of the American Pharmaceutical Association have been elected as follows: *President*, H. A. B. Dunning, Baltimore, Maryland; *first vice-president*, A. L. I. Winne, Richmond, Virginia; *second vice-president*, W. B. Goodyear, Harrisburg, Pennsylvania. The next annual meeting of the association will be in Rapid City, South Dakota, from August 26 to 31.

PROFESSOR P. J. HANZLIK, professor of pharmacology at Stanford University, and Dr. H. G. Mehrtens, professor of neuro-psychiatry have received a grant of $3,000 from the Committee on Research in Syphilis for their cooperative research on the treatment of syphilis. This work was further supported by a gift of $1,000 received by Professor Mehrtens from Mrs. Anne Tallant Brodie.

WILLIAM S. MONROE, president of Sargent and Lundy, Inc., has been appointed to membership on the American Society of Mechanical Engineers Standardization Committee for the term 1928–1933. Mr. Monroe will take the place of A. M. Houser, whose term of membership has just expired.

DR. E. E. JUST, professor of zoology at Howard University, and Rosenwald Fellow of the American Research Council, sailed on January 3 for Naples. While in Naples he will be the guest of the Prince of Monaco, conducting experiments in the Prince's private laboratory. He will also be associated with Dr. Doorn of the Naples Station. The special investigation which carries Dr. Just to Italy is the life cycle of the marine annelid *Platynereis dumerilii* which appears to be closely related to the species which Dr. Just has worked on at Woods Hole, Mass., for the past fifteen years.

E. R. SCHIERZ, associate professor of chemistry at the University of Wyoming, is on sabbatical leave for the school year 1928–29. During the first semester he is working in the laboratory of Geheimrat Heinrich Wieland, Munich, Germany, and during the second semester he expects to visit other laboratories on the Continent.

DR. JAMES H. BREASTED, professor of archeology and oriental history in the University of Chicago, has sailed for Egypt with the party of Mr. John D. Rockefeller, Jr.

COLONEL J. D. GRAHAM, representative of India on the health committee of the League of Nations and Office Internationale, Paris, public health commissioner with the government of India and secretary of the governing body of the Indian Research Fund Association, is visiting the United States as the guest of the Rockefeller Foundation.

PROFESSOR MARY SCOTT SKINKER, of the department of biology of the Pennsylvania College for Women, Pittsburgh, Pennsylvania, is on leave of absence for the academic year of 1928–29. During her absence Dr. Anna R. Whiting will substitute as head of the department and professor of biology.

L. B. ALDRICH left Washington on January 1 for the Smithsonian Observatory at Montezuma, Chile, for the purposes of inspection and of making certain improvements in the equipment there.

DR. N. B. DREYER, of the department of pharmacology, McGill University, who during the past few months has been in charge of the department of physiology of Dalhousie University, has returned to Montreal. Dr. Dreyer was granted a special leave of absence from McGill early in October, in order to direct the laboratories at Dalhousie until the arrival of the present departmental head, Dr. E. W. H. Cruikshank.

THE next course of Lane Medical lectures will be given in April by Professor Walther Straub, of Munich. Professor Straub has announced the following program: "Pharmacology of Heavy Metals," "Chemistry and Pharmacology of Digitalis and Its Derivatives" and "Recent Developments in Narcosis."

Dr. L. H. Germer, of the Bell Telephone Laboratories, New York, addressed the Sigma Pi Sigma Honor Fraternity and the North Carolina Physics Colloquium meeting at Duke University on December 7 on "Some Optical Experiments with Electrons."

Dr. Joseph L. Miller, donor of a rare collection of medical books to the Richmond Academy of Medicine, will speak on "Physicians of the Old South, their Character and Education" on founder's day at the Medical College of Virginia, on February 15. On the same occasion Dr. Charles R. Robins, professor of gynecology at the Medical College of Virginia, will read a paper on the beginnings in nursing education in the modern sense at the Medical College of Virginia.

Dr. Joseph Sailer, professor of clinical medicine at the University of Pennsylvania, died on December 31, at the age of sixty-one years.

Joseph Willard Legg, of the engineering staff of the Westinghouse Electric and Manufacturing Company, known for his work in oscillography, died in Wilkinsburg, Pennsylvania, at the age of forty-one years.

A correspondent writes: "Chester G. Van Buren, born at Orangeville, Utah, November 15, 1875, who spent three years 1900–03 collecting zoological specimens for the Brigham Young University in Colombia, South America, died in Chicago, December 18, 1928. Mr. Van Buren collected 1,200 birds, a few mammals, several thousand insects, mainly butterflies, and a most interesting collection of pottery and Indian relics. These specimens and two group studies of the life of the Magdalena River region with its micos, peccaries, coral snakes, tucans and ant-eaters remain as a reminder of Van Buren's love of nature."

At the eighth annual meeting of the Chicago Botany Alumni held in New York on the evening of December 27 there was presented to the University of Chicago $25,000 to be known as the John M. Coulter Research Fellowship Fund. It was hoped that Professor Coulter, who died on December 24, would be present. The sum for the fellowship had resulted from the contributions of 130 doctors and 75 other alumni and past students of the department of botany over which Dr. Coulter had presided for so many years. The interest only of this fund is to be used for an annual pre-doctorate fellowship, tenable in any branch of plant science at the department of botany of the University of Chicago. The presentation was made by Professor R. B. Wylie, Iowa State University, and accepted on behalf of the University of Chicago by Dr. Max Mason, of the Rockefeller Foundation, formerly president of the University of Chicago.

Dedicatory exercises were held on December 5 for the new dispensary and outpatient department of the Johns Hopkins University School of Medicine, Baltimore. Dr. Frank J. Goodnow, president of the university; Dr. Henry S. Pritchett, of the Carnegie Corporation; Drs. Warfield T. Longcope, professor of medicine; Winford H. Smith, director of Johns Hopkins Hospital, and William H. Welch, professor of the history of medicine, were the speakers. The *Journal* of the American Medical Association recalls that the Carnegie Corporation in 1923 gave to the ance of the dispensary, which is a memorial to the university $2,000,000 for the erection and mainten-friendship between Andrew Carnegie and Daniel Coit Gilman, first president of the university and of the hospital, who was chosen by Mr. Carnegie to be the first head of the Carnegie Institution of Washington. The building was completed some time ago at a cost of $1,100,000; the remainder of the fund given has been set aside as endowment for maintenance. There are accommodations for the treatment of more than 1,200 persons daily, most of which will be free service for the poor. Special arrangements will be made, however, for persons of moderate means.

A committee to serve as a clearing house between explorers and scientists has been appointed from the American Museum of Natural History, the Explorers' Club and the National Research Council, according to an announcement by the division of engineering and industrial research of the latter organization. The joint committee is the outgrowth of a dinner given recently by the Research Council at which members of the two other organizations were guests. At that time resolutions approving such a committee were adopted, and the appointments were made at the suggestion of Dr. Elmer A. Sperry, who appointed the members from the National Research Council. Dr. Sperry pointed out that much good could grow out of a closer cooperation between explorers and laboratory workers. The American Museum committee appointed by Dr. Henry Fairfield Osborn, includes Dr. Roy Chapman Andrews, Dr. Frank L. Chapman and Dr. Harold E. Anthony. The Explorers' Club committee, appointed by George G. Heye, president, includes Fitzhugh Green, George Palmer Putnam and Dr. Robert Cushman Murphy. The committee appointed by Dr. Elmer A. Sperry for the council includes Dr. E. E. Free, Dr. C. L. Reese and Maurice Holland. Dr. Osborn, Mr. Heye and Dr. Sperry will be *ex-officio* members of the joint committee.

UNIVERSITY AND EDUCATIONAL NOTES

DR. GEORGE ALFRED LAWRENCE, the neurologist, of New York City, who died on December 28, made bequests of $1,000,000 to Stanford University, his alma mater, and to the All University Club, of which he was an organizer. In addition Dr. Lawrence willed equal shares in his residuary estate to Stanford University and the All University Club.

AN anonymous donor has contributed $50,000 to establish a chair of preventive medicine in Queens University, Kingston, in honor of Dr. Arthur Elliott, an alumnus.

THE Kansas State Agricultural College has been placed upon the list of institutions of higher education approved by the Association of American Universities.

AT the University of Virginia, Robert E. Lutz has been appointed associate professor of organic chemistry, Lauren B. Hitchcock associate professor of chemical engineering, and Lyndon F. Small research associate in organic chemistry.

DR. ALVAH R. MCLAUGHLIN has severed his relations with the department of physiology and pharmacology of Michigan State College in order to accept the position of physiologist and pharmacologist at the experiment station of the University of Wyoming. He will assist in the investigations of plants poisonous to livestock.

DR. THOMAS P. HASLAM has been appointed associate professor of pathology at Baylor University College of Medicine, Dallas, and medical director of the Baylor Hospital.

CHARLES E. BRAUN has resigned from the research staff of the Barrett Company to become assistant professor of organic chemistry at the University of Vermont.

DR. JAMES HENRY DIBBLE, professor of pathology and bacteriology in the Welsh National School of Medicine, Cardiff, has been appointed to the George Holt chair of pathology in the University of Liverpool. Professor Warrington York has been transferred to the Alfred Jones chair of tropical medicine.

DISCUSSION AND CORRESPONDENCE

IS THIS SCIENCE OR METAPHYSICS?

THE Silliman lectures at Yale University have been the avenue through which some of the masterpieces of modern science have been published. Among these lectures are the "Integrative Action of the Nervous System" by Sherrington and "Respiration" by Haldane. Among the other lecturers on this foundation appear the names of Krogh, Morgan, Thompson, Nernst, Rutherford, Arrhenius and Bateson. In such company the highest standard of true science should be expected. This expectation is further justified by the fact that the Silliman Foundation expressly provides "that lectures on dogmatic or polemical theology should be excluded." It is, therefore, to be noted with regret that the lectures in this series recently delivered by Professor Lawrence J. Henderson are seriously infected with that most insidious disease of scientific thought, metaphysics.

The subject of the lectures now published,[1] according to the opening paragraph, is "the red blood of vertebrates," to be studied "both as a physico-chemical system and as a tissue," considered both in the "interrelation of its physiological functions" with other parts of the body and as "an illustration of organic integration and adaptation."

A general conception of protoplasm from the standpoint of a physicochemical system is then presented, and this is followed in the second chapter by a statement of the components and functions of the blood as a type of protoplasm or of the nearest approach to protoplasm that has yet been analyzed with any degree of thoroughness. The discussion then turns to a presentation of the acid-base equilibrium of blood as depending upon the balance between sodium bicarbonate and carbon dioxide in simple solution. The influences exerted by the cells of the blood and by the proteins and other buffers of the plasma are brought out. Up to this point dissociation curves of the usual form are chiefly used in the graphical presentation of the facts. The number of factors involved in the physicochemical equilibrium in so complex a system as blood is found, however, to exceed the limits of ordinary graphic representation; and on this account the author has recourse to the use of nomograms as devised by d'Ocagne, in which it is possible to represent the interrelations of a larger number of factors. The shift of the equilibrium within the blood during the normal respiratory cycle is shown in a series of 100 successive diagrams, and this is followed by two other series of diagrams, one of five and the other of twenty-one separate figures. In fact the total number of figures in this book, exclusive of the appendix, is 225, and the tables are eighty-six in number. The presentation of the material is thus extremely full. Following the chapters dealing with the influence of respiration and with the blood in circulation are chapters presenting evidence regarding readjustments in the blood during

[1] "Blood, a Study in General Physiology." By Lawrence J. Henderson, Yale University Press, 1928. Pages 397, price $5.00.

muscular work and in disease, and on the blood of non-mammalian species of animals.

In the last chapter the conclusion is reached (page 373) that

> the elementary condition of the phenomena of life is a particular kind of physico-chemical system. A description of this kind of system so general as to be almost but not quite useless is given. . . . Although the greater part of this book has been devoted to the elucidation of the properties of this class of systems a comprehensive and detailed description is as yet unattained. . . . Some will say that the elementary condition of the phenomena of life is the cell. Others will prefer a metaphysical definition.

Such, in brief, are the contents and professed objects of this book. It is a work which, for several reasons, is peculiarly difficult to evaluate. It will be hailed by some as a masterpiece—the more admiringly, perhaps, the less they understand it. But it is perverted from the splendid service which it might have rendered by the obscurity with which the general ideas are presented, by the behavior of the author toward that investigator who in this field was his chief predecessor, and by his attitude toward his readers, whom he seems to desire to impress rather than to inform. Certainly few who are not already well informed on this subject will find it helpful to read such a sentence as the following (page 15):

> Thus the stability of the alkalinity of blood and protoplasm may be measured by the value of a mathematical function which is implicit in the general mathematical description of the equilibrium between acids and bases, and the regulation of alkalinity, that is to say, its relative constancy over a long period of time and under widely different circumstances, may be quantitatively described if we extend our studies from the physico-chemical equilibria of blood and protoplasm to the interaction of these with the activities of the lung and the kidney, and with the varying processes of metabolism.

In extenuation of this manner and style it is only fair to add that these faults of the book are faults only when it is considered as science. They are quite in the manner of metaphysics, and the author indicates both on the first and last pages of his text that he conceives of science as attaining its final aim only when it becomes metaphysical or has passed through a stage of metaphysics. Thus on the first page of the book he describes his conception of the development of the sciences as follows:

> At first descriptive and classificatory, then rational, in this twentieth century some will say that they are destined to become metaphysical. But before they can attain to this last condition it seems probable that they must pass through a stage in which all is clarity, simplicity and order, where there is no room for philosophic doubt and where, by a singular paradox, the adoption of approximations and philosophically dubious abstractions yields certainty, or at least the closest approach to certainty that man has ever known.

This statement might have emanated from Theophrastus Bombastus von Hohenheim, the celebrated medical writer and mystic of the sixteenth century, generally known as Paracelsus.

It may be that in some other fields, for example mathematical physics, "philosophically dubious abstractions yield certainty," particularly if no experimental test is possible. But in the biological sciences with their infinite variety of phenomena all real advance has been due to experiment and observation. Doubt and question have been the mainsprings of progress; and "dubious abstractions" can be regarded only as perversions. Let us see what the author's method comes to. He says (page 17):

> Far from seeking to avoid or to minimize the adaptive character of organic phenomena, we should, I believe, invariably take this for granted. The law of adaptation in organisms, founded upon the fact of survival, seems to be quite as well established as the second law of thermodynamics, and almost equally serviceable. Caution is, however, necessary and *Candide* should never be forgotten, for one must carefully avoid in studying the microcosm, the ancient fallacy of the best of all possible worlds.

Ths passage has already been hailed even by an able physiologist as the impressive dictum of "one of the most profound of modern thinkers." But stripped of its metaphysical and pedantic form of expression it comes to absolutely nothing more than the idea expressed nearly seventy years ago by a quite unmetaphysical observer of nature in a quite unmetaphysical book, Charles Darwin in the "Origin of Species." The words above quoted are simply a statement of "natural selection" with no greater content or connotation than the definition and description of Darwin's central idea as presented in simple language in any elementary text-book of biology.

The difference in the method of thought and the presentation of fact in the "Origin of Species," or in any other truly scientific work, and the method employed in the book before us is that true science invites experimental tests and if possible correction or even refutation at the hands of others. In such metaphysical science as this book, on the contrary, nearly every general statement that could be tested experimentally is provided with "weasel words" through which, if the experiment is adverse, the statement can be explained as meaning something different from the sense in which it was understood initially. It can thus be shown even to have foretold

the result of the experiment, after the event; for, as the author would say, "The principle remains the same." To criticize the scientific standpoint of this book would, therefore, be like shooting at a disappearing target.

But if the discussion of the regulation of the composition of the blood is taken for what it seems to mean, it presents a conception of equilibrium which is sound physical chemistry, as it deals with stationary states, but is essentially erroneous as a description of physiological functions, since the characteristic equilibria of life are dynamic. The energy equilibria of the organism are as much in flux as the chemical equilibria of metabolism.

Evidently the author of this book in lifting the subject of the regulation of the blood equilibrium from an experimental to a mathematico-metaphysical basis feels that his predecessors and contemporaries, who have worked in this field by merely experimental methods, deserve little credit, if indeed he condescends even to mention them. He recognizes fully and properly the splendid contributions of Van Slyke. But toward Haldane (whose contributions from an experimental standpoint are really so immense that without him and his collaborators the subject of this book would scarcely have existed), the author at times uses a derogatory tone which violates the ethics of scholarly relations and which every one who has followed the development of this subject must condemn. Of one matter, which is almost the central point of the entire book, the author says (pages 80 and 81):

> To those who have not themselves experienced that state of bewilderment which is the usual condition of the investigator, it must seem strange that the physiologists who were studying the respiratory function of the blood should not have drawn . . . the conclusion that, since carbonic acid influences the oxygen equilibrium in blood, oxygen must influence the carbonic acid equilibrium. If proof of so obvious a condition is necessary a mere glance at the above equation will suffice. . . . Yet so little are physiologists accustomed to mathematics and such is the natural inertia of the mind, that this conclusion escaped us all and it remained for Christiansen, Douglas and Haldane to discover by experiment that the carbon dioxide dissociation curves of oxygenated and of reduced bloods are different.

Others do not think it so surprising that this discovery was made by Haldane and his collaborators.

The final evaluation of such a book as this must depend on whether it leads to further experimental advance or, on the contrary, encourages others to imitate its obscurity, its metaphysics and its condescension toward experimental workers, whom it further discourages by overloading the field with unnecessary technicalities. Certainly no worse example can be offered to those who in future should carry science forward than that of an eminent scientist and scholar preferring to impress his readers with his own profundity and erudition rather than to inform them by a clear simple and modest statement of the facts and theories of the subject.

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WORDS AND LIFE

To say the least, scientists are now being afforded a little amusement in the field of agronomic advance with respect to the creation and adoption of a suitable terminology. In spite of the humor and irony and sarcasm which appear ominously to be in the air in the discussions of the matter, there is a deep organic side perchance which sooner or later must be faced squarely. Love, language, life are no trivial playthings of scientists, but deep and vital moods of being, which are not easily subject to deliberately controlled extensions and prohibitions as one sees fit to make them. Language is no fixed entity but a facile thing, reflecting all the moods and modes of life. It begins with no group; it ends with no group. Words as we use them come from all the classes and castes among us, good or bad, and they perish or survive as the moods of the times would decree, oftentimes as the man of the street decrees. Men will not have words put into their mouths or taken out of them, only as they themselves will it. Years ago the writer left a little New England town to enter the doors of the University of North Carolina. In one of its English courses he wrote a theme using the word *swale* for a small meadow. It was thrown out unconditionally as a word not complying with the linguistic canons of *good use,* and he was given to understand a word must not be used which was not in present, national and reputable use. *Swale* withal is a good English word in New England, for a tiny meadow. It was suggested politely that the writer was provincial in his language. I still cling stubbornly to the good word swale for my tiny meadows, nevertheless, because it has a history, because it is a part of me, because I am more or less of an individualist and do not care to be standardized in every detail of my life by outside groups. We may easily invent new words but their universal adoption into the everyday English language is quite another matter. If the people wish them, they take them, good or bad, whatever their history, meaning, application, and no force of life will check them. As our language exists to-day, the agronomists, the botanists, the pathologists,

in truth every scientific group is doing only what the various economic groups are doing, inventing and using words for their own use. They need not become generally known, and in truth they do not. Years ago before entering into the sacred cloisters of our imposing monasteries of science, I was fortunate enough to make a trip to London on a *jolly* English cattle boat as a *bally* cattleman. Here did I find a new diction I had never heard before. I had to learn not only a new code of ethics and life and philosophy, but a weird new language. A potato was eternally a *spud;* a big roll which looked like a plain bun was always a *cob;* plain meat and potato stew was always *lobscouse,* and on and on. This was the plain spoken language of the roaming galleys of the high seas, and I fell in naturally, normally, willingly, for there is no escape among these Romans, so to speak. The best writers do not make our language necessarily but oftentimes the people themselves. Dwell among the sea tramps and you find one language; among the land tramps another. The iron-workers, the bricklayers, the carpenters, in truth every specialized group of workers, whether in economic or scientific fields or what not, has its current usage. If one writes for carpenters he must know their special language, their tool-names, etc., and weird and incomprehensible are some of them too. A preacher for the general mass of humanity is a religious preceptor or interpreter; but the carpenter-guild have a handy little tool which is a narrow piece of board with a parallel-sided cleft at one end sufficiently wide to allow the insertion of boards. It is used to cut siding squarely with the window frame, or floor boards with the door frame, etc. It, too, is a "preacher" in their parlance. Nevertheless it is a very restricted word in its usage, and rarely has the average man heard preacher used in this connection. Yet who shall presume to be so élite that he will refuse to use it if the occasion demands, or invent for it a new word? The carpenter guild somewhere, sometime have invented the word, and it is going to stay with them and for them, contrary to all the interdictions of any élite writer among us who would presume to talk of a present, a national and a reputable test to make it good usage. It was in our monasteries of science and education that I was told to renounce this or that word, this or that spelling, this usage or that, but I have found that education, artificiality, etc., are one thing and language, mood, life another.

Words seep into the language from every source, and may or may not become the vernacular of the street, the common passwords of the day. The word "bughouse" originated with that notorious woman-tramp of Josiah Flynt's experience, Boston Mary. It left the underworld brotherhood with powerful wings, and is now or has been the slang of the élite among us more than once. No one has unraveled all the mysteries of words, their origin, use, final reversals of meaning or death. "Storied windows richly dight" meant much to Milton and others of the day, but who can resurrect the good old word "dight" mummified to-day and make it living coin again? Who shall make the detestable "imp" of to-day the small boy of yesterday? Words have their day and die with our moods, just as our fashions and customs and laws, and no one man or one group has much to do about it, it would seem. Telephone, telegraph, radio, and hundreds of other words have become common, readily understood property from the laboratories of science; but people accepted them because they came into the possession of new devices and found it necessary to label them. Bans, interdictions, prohibitions even with a death penalty will not stop a trend, a mood among men. There were times in the ancient days of Europe when smoking was punishable with torture and even death penalties, but pipes, cigars and what not that could be smoked became ever larger, ever more ubiquitous. Moods and laws die natural deaths, rarely violent deaths by gun or sword or rack.

Back of language then, is natural law and life in its most subtle manifestations, and what one restricted group says or does or recommends will not necessarily change matters seriously. I spell *thru* under a secret protest, for it is too much like pulling one bent straw from a hay stack, and then feeling one has done much to straighten all that remain. Our language is a living thing with all the moods of life and death in its make-up. A dead shelf-language like the Latin appears as a dried and shrivelled mummy, but men still persist in carrying it around, and the mere carrying will surely change it, and sooner or later make it reflect some of the whims of modern life. Volapuks and Esperantos may come and go, but the best of these pulse with very weak sparks of life and heartbeat in spite of the most entreating and vigorous scientific sanctions. The agronomists would do only what every minor group of the great web of life is doing, make a more or less restricted dictionary of their own, for their own understandings, not for the universal usage and understanding of humanity. The term "preacher" as a tool-name exists for carpenters alone, and no amount of "preaching" is going to make the man or woman of the street carry a little "preacher" in his pocket. It is not even recorded in the respectable dictionaries of the English language, but a respectable dictionary is no true index of living vernaculars, words, usages, etc.

The sequestered cloisters of our monasteries of science are going to play a very minor part in the adopted usage of the people. There are already many Esperantos among us, scientific and otherwise, yet all unknown except to the restricted group which speaks them. It may be a comparatively simple matter to introduce a scientifically coined name for a totally new device, as telegraph, telephone, radio, etc., for people have no alternative but to accept it. People may accept a new term as a slang novelty, just as they seized greedily upon the common, low-bred word "bughouse." It is another matter, however, to make them forget or distort old, familiar usages, recommended by limited groups of society, regardless of their refinements or fitness in the last analysis.

Even the laws of simple pronunciation seem not well understood. The vernacular of the New Englander is never going to agree with the vernacular of the South Carolinian or the Kansan, etc. It is no intentional committal toward or away from purities of intonation, etc., but a variation, natural and normal to the locality somehow, based on some of the deep, mysterious physiologies of life which have not yet been very well understood. I can detect significant variations in the singing of different katydids of the same morphological species in different regions. Some have adopted a widely different "song" but in other groups there is a vernacular difference. For instance, the Oblong-winged Katydid (*Amblycorypha oblongifolia*) in New England rasps with subtly different intonations and accents from the Washington forms. E. E. Snodgrass, of the Bureau of Entomology, U. S. Department of Agriculture, has noted similar differences in the notes of the New England groups and the Washington, D. C., groups of the True Katydid (*Pterophylla camellifolia*). Bentley B. Fulton has reported similar findings with certain crickets (*Oecanthus*). Certain birds are known to sing better in some localities than others. So even the purity of the spoken King's English affords a legitimate subject for the analyzing scientific mood when need be, but one which has implications even in the "voices" and vernacular of crickets and katydids perchance. Even the purity of the spoken word is not so simple as would at first appear, for back of it all is the intricate physiology of life, mood and mode, and back of it all are the refinements of climate, food, habit, heredity, tradition and what not in the universe.

This discussion takes no stand against any one, for it is well to keep on the calm, dispassionate side, but to the writer language is a beautiful thing because it is a living, plastic, versatile function having its weal and woes in the very warp and woof of life itself, subject to no man's whims or moods, keeping its mannerisms if need be, growing others, but as resisting and as irresistible to deliberate conscious chopping and hewing as the trends of life which give it birth.

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AN EXPERIMENTUM CRUCIS IN DIABETES

The problem of diabetes is again in a stalemate. Diet therapy and insulin have yielded their major contributions and probably have little more to offer. Before the problem of therapy can be again brought out of the blind alley in which it now stands, it must be determined whether the islet tissue of a diabetic individual is really a wrecked chemical factory, or whether it is intact. Pathologists are not agreed that the histologic changes that are commonly present adequately account for the failure of the internal function of the pancreas in diabetes. It is therefore an open question, of the first importance, to determine the functional state of the pancreas in diabetes, so far as the production of insulin is concerned. This question can be answered by determining whether the pancreas of a diabetic can be restored to normal function when transplanted into a healthy animal. The first step in the experiment would consist in making and establishing the transplant into the healthy animal. After this is accomplished it would probably be necessary to depancreatize the animal, unless the sum of insulin production of the pancreas *in situ* and that of the transplant could be effectively determined. If the transplant was now found to produce more insulin than it did in its former habitat, the experiment would indicate that in some cases of diabetes at least the loss of function is due to an environmental factor.

Although insulin is not as sensitive to chemical influence as was at first thought, it is by no means inert. Moreover, it can be inactivated *in vitro,* in ways that are not too remote from conditions that can exist in the organism. It is also well known that the glucose metabolism of a diabetic, which is a measure of his insulin production, varies with several circumstances. Such considerations, which need not be discussed in detail, make it possible that in diabetes one of two conditions may exist: (1) Either the formation of insulin by the intact islet tissue is prevented by the chemical influence of some environmental fact, through the presence of some inhibiting substance or through the absence of some chemical link in the process; (2) or the insulin produced in normal amounts is rendered useless by some other chemical condition in the organism. In any case the detailed

analysis of such possible environmental influences seems altogether too difficult technically unless and until the existence of a possible environmental factor is established as a fact.

Unfortunately this experiment can not be done on men, and spontaneous diabetes is rare in dogs. Since the chance is remote that the required animal material will be obtained in any given laboratory, it seemed wise to "broadcast" this suggestion so that the hypothesis may be tested if and when suitable dog material becomes available somewhere in the world. Owing to the great importance of such knowledge to men in general, it is suggested that all workers be prepared to avail themselves of or to turn over to colleagues any animal that would be suited for these experiments.

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TWO ADDITIONS TO THE HERPETOLOGICAL FAUNA OF RILEY COUNTY, KANSAS

SINCE two recent papers by Charles E. Burt[1] have listed the reptiles and amphibians of Riley County, Kansas, it seems worth while to call attention to two species hitherto unrecorded from this locality.

In the early fall of 1923 a specimen of the western hog-nosed snake, *Heterodon nasicus* Baird and Girard, was taken near Manhattan by a student and brought to the museum of the Kansas State Agricultural College. The specimen can not now be found, but since I examined it personally I am sure of the identification. This appears to be the easternmost Kansas record for this species.

The other new record is that of a western toad, *Bufo cognatus cognatus* (Say), which was collected July 12, 1928, five miles northeast of Manhattan not far from the Blue River. One individual, a large female, was picked up while crossing a small lane about 10:00 P. M. This locality appears to be on the eastern edge of the range of this species. Specimens of this form from Geary County, which adjoins Riley on the south, are preserved in the museum of the University of Kansas. No other records from the eastern third of the state are known to me at the present time.

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[1] "An Annotated List of the Amphibians and Reptiles of Riley County, Kansas," Occas. Papers Mus. Zool., Univ. Michigan, No. 189, 1927, pp. 1–9; and "A New Amphibian Record from Kansas, *Hyla phaeocrypta* (Cope)," SCIENCE, 1928, 67: 630–631.

SCIENTIFIC BOOKS

Études d'Histoire des Sciences Naturelles. I. *De Linné à Jussieu. Méthodes de la classification et idée de série en botanique et en zoologie (1740–1790).* Par HENRI DAUDIN (Paris, Librairie Felix Alcan), ii + 264 pp. Price 20 fr. II. *Cuvier et Lamarck. Les Classes Zoologiques et l'idée de série animale (1790–1830).* Par HENRI DAUDIN (Paris, Librairie Felix Alcan). Vol. 1, xiv + 460 pp.; vol. 2, 338 pp. 1926. Price 60 fr.

THE period of the initial systematic organization and classification of the plant and animal world is the last half of the eighteenth century. In this brief time of a half century the plant kingdom, barring the Protophyta, was fairly well classified along modern lines. The animal kingdom did not fare as well, largely because the anatomy of the invertebrates was so inadequately known. In this period two points of view were in more or less conflict: the one developed the "methodical" system, largely Aristotelian in origin, and the other the idea of seriation, which progressed from the scale idea of Bonnet to the dendritic concept of Donati. As investigation progressed the constant discovery of intermediate genera and species and the emergence of multiple liaisons for one group after another caused a marked tendency for a continuous weakening of the "methodical" concept, and it became less and less tenable as the concept of ramifying, or rather branching, series developed. The scale of being was, however, traced downward perhaps more often than upward, as in Buffon's primates.

A meticulous analysis of the work of the major contributors to systematics of this period fails to reveal any evidence, in either philosophical interpretation or in objective handling of the data of classification, that any one of them ever conceived the series as anything more than those of structural resemblances, valuable as guides to a natural system of classification. No statement of a genetic seriation or of genetic relationship emerges in this period. The data guiding their efforts to create a natural system and the very nature of their perplexities were, however, of basic value in the later contest between Cuvier and Lamarck, but transformism was not yet born.

The second work is a serious and scholarly treatise which seeks to evaluate the work of the two divergent French schools of biological interpretation represented by Cuvier and Lamarck, and thus to portray correctly the background of the transformist theory which historically preceded the Darwinian epoch in the development of evolutionary thought. Whatever was new in the theory of natural selection can be fairly assessed only when the content of French trans-

formism is adequately understood. To gain this understanding the author has made an analytical study of the ideas of these two leaders of French zoological thought, not only as expressed in their own formulations of their philosophical ideas as to the organization of, and changes in, the living world, but also as they emerge in, or appear to modify and direct their interpretation of, the structure and classification of animals.

Both schools worked under the limitations of the anatomical method. They were alike, though not equally, without comprehension of the magnitude, value and significance of the developmental phase of animals opened to them by the work of von Baer, and neither seems to have made any serious effort to utilize the then very imperfect microscope to enlarge his concept of the living world. Indeed it seems to have been in their view more of a toy than an instrument, and its revelations seem to have had a nuance of unreality about them. Ehrenberg had not yet published his "Infusionsthiere," and the monographs of O. F. Müller did not direct the French savants from grosser and seemingly more substantial objects of investigation.

Thus, to a large degree, both were without the immense incentive to the idea of progression which the unicellular structure of the Protista afforded to systematists working subsequent to the statement of the cell theory in 1838–39. The hand lens was an auxiliary only to dissection. The classical mode of zoological investigation was well intrenched, and the microscope itself was as yet hardly in a stage of development to invite its use as a primary instrument of exploration. The complexity of the microscopic world of life had not been realized, and the significance of the structural distinctions between Bacteria, Protozoa, Protophyta, microscopic Metazoa such as the Rotifera, Tardigrada, the smaller flatworms and the microscopic larval stages of the larger Metazoa, had not been made, largely because of a lack of cellular knowledge and its bearing on development. It is not strange that the little that was known was so little used when we recall the fact that the free-swimming larval Cercaria of the Trematoda were classified with the dinoflagellate *Ceratium* and that Ehrenberg even in the time of the second edition of the "Histoire Naturelle des Animaux sans Vertèbres" (1835–45) was still finding guts and sex glands in the Ciliata, and that Linnaeus had utilized the significant names of *Volvox* and *Chaos*, that *Vibrio* and the Nematodes were put together, and that a miscellaneous assemblage of quite unrelated organisms was included in the Infusoria, named not from their structure but from their breeding place.

Lamarck was early imbued with the idea of the seriation of the organic world, though he vigorously set forth the independence of the organic and the inorganic and also the distinctions of the plant and the animal series. In his later work the idea of a linear series gave way more and more to the dendritic concept in classification.

To Lamarck the maximum simplicity of micro-organisms was of great significance, while the tendency on the part of Cuvier was to disparage the significance of their small size, to emphasize their complexities and resemblances to larger forms of life and to distribute them, for example, putting Vorticella with the Zoophytes. Of all the reforms in classification initiated by the work of Lamarck by far the most significant and brilliant one was the establishment of the Protozoa as a distinct phylum. This grew out of his recognition of the simplicity of at least some of the "Infusoria." The Rotifera caused him no little trouble, though he recognized their distinctions. An extended comparison of Cuvier's and of Lamarck's treatment of the Arthropoda is used to demonstrate more fully the divergence of their methods.

The author has done a great service to students of the history of biology by tracing in considerable detail the influences which the ideas of Cuvier with regard to "types" and of Lamarck with regard to "series" had upon their systems of classification and their respective evaluation of diagnostic characters. Of especial value is his development of the growth of the idea of seriation as expressed in the systematic work of Lamarck.

A useful annotated bibliography accompanies each of these treatises.

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REPORTS

REGISTRATION IN AMERICAN UNIVERSITIES

ACCORDING to an Associated Press dispatch an increase of 2 per cent. in enrolment, the smallest annual gain since the war, is shown in reports received by Dean Raymond Walters, of Swarthmore College, from 216 colleges and universities throughout the United States which are on the approved list of the Association of American Universities.

These reports, as presented in *School and Society* for December 15, 1928, show increases in 115 institutions and decreases in 101 institutions, comparing the November 1 registrations with those of a year ago.

An analysis by states shows that in twenty-six states there are more full-time students in approved colleges and universities than in 1927, and in twenty-two states there are fewer such students.

The 1928 full-time enrolment of the 216 institutions totals 417,526. The preceding five-year increase totaled 25 per cent.

"The returns of the next half dozen years must be awaited," Dean Walters writes, "to determine whether a definite break has come in the rate of increase in college enrolment."

He cites the diminishing birth-rate in America and restricted immigration as factors that will be effective in the future.

Dean Walters quotes various suggested explanations of the enrolment decreases, such as agricultural and industrial conditions, the development of junior colleges, a trend in certain areas away from the small colleges to the state universities and deliberate limitation of enrolment. He says:

"The present collegiate period, if it is a plateau, is nevertheless a plateau 25 per cent. higher than it was five years ago and very markedly higher proportionately than any similar popular level reached in other countries."

Tables in the *School and Society* article show that of the small colleges having enrolment up to 500 students, 24 report increases and 30 report decreases; institutions of 500 to 1,000 students, 30 have increases and 31 decreases; institutions of 1,000 to 3,000 students, 34 have increases and 22 decreases; universities of 3,000 students and upward, 27 report increases and 18 decreases.

The states and territories having more full-time students this year than last are: Arizona, Arkansas, Colorado, District of Columbia, Florida, Hawaii, Idaho, Illinois, Indiana, Kentucky, Maine, Massachusetts, Michigan, Minnesota, Mississippi, Montana, New York, North Carolina, North Dakota, Ohio, Oregon, Tennessee, Texas, Virginia, Wisconsin and Wyoming.

The statistics give first place in full-time enrolment to the University of California (including divisions at both Berkeley and Los Angeles) with 17,337 students, Columbia University is second with 13,691, University of Illinois third with 12,150, University of Minnesota fourth with 11,815 and University of Michigan fifth with 10,954.

Counting part-time and summer session students, as well as full-time regulars, the ranking of the highest five for a grand total enrolment in 1928 is somewhat different, as follows.

Columbia, 32,036; College of the City of New York, 28,287; California, 26,562; New York University, 26,303; Minnesota, 17,856.

The full-time enrolments of universities ranking sixth to twenty-fifth are as follows:

New York University	10,711
Ohio State University	10,293
University of Wisconsin	9,042
Boston University	8,520
Harvard University	8,110
University of Washington (Seattle)	7,282
University of Pennsylvania	6,711
University of Pittsburgh	6,235
University of Nebraska	6,235
University of Texas	5,794
University of Chicago	5,628
Northwestern University	5,559
Cornell University	5,315
Syracuse University	5,188
State University of Iowa	5,047
Yale University	4,990
College of the City of New York	4,929
University of Oklahoma	4,604
University of Cincinnati	4,297
Fordham University	4,175

For grand total enrolments, including part-time and summer students, the order of universities ranking sixth to twenty-fifth is as follows:

University of Pennsylvania	14,844
University of Illinois	13,010
University of Wisconsin	12,939
University of Michigan	12,890
University of Pittsburgh	12,674
Ohio State University	12,662
University of Chicago	12,662
Boston University	12,234
Northwestern University	12,038
Western Reserve University	10,832
Harvard University	10,793
University of Washington (Seattle)	10,339
University of Cincinnati	10,328
University of Nebraska	8,897
University of Texas	8,259
University of Iowa	8,026
Fordham University	7,859
Cornell University	7,465
Syracuse University	6,882
University of Oklahoma	6,664

Of the women's colleges on the approved list, the ten largest in full-time students are:

Hunter College	4,918
Smith College	2,022
Wellesley College	1,592
Florida State College for Women	1,550
Vassar College	1,156
Mount Holyoke College	1,006
Goucher College	979
Radcliffe College	907
Randolph-Macon College	795
Elmira College	588

Reporting that, "in general, summer school attendance in 1928 showed no great increase over the 1927

figures," Dean Walters gives the five largest summer session enrolments as follows:

Columbia University	14,007
University of Chicago	6,338
University of Minnesota	6,641
University of Wisconsin	5,065
University of California	10,228

SPECIAL ARTICLES

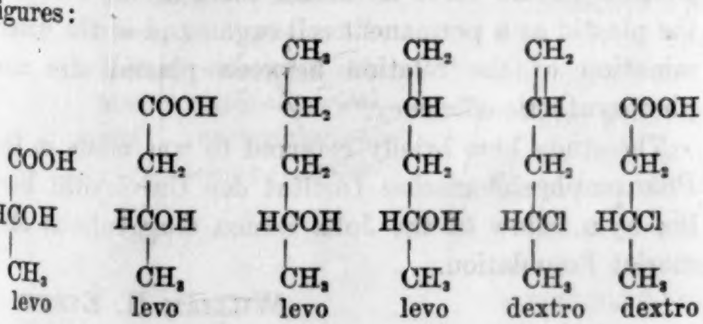
ON THE CONFIGURATIONAL RELATIONSHIP OF 3-CHLOROBUTYRIC AND 3-HYDROXYBUTYRIC ACIDS

IN recent years reports have appeared from several laboratories on the correlation of the configurations of hydroxy and of halogeno acids. The conclusions reached by different authors are quite contradictory. As an illustration two pairs of acids may be mentioned, namely, lactic and chloropropionic acids and malic and bromo- or chlorosuccinic acids. According to Clough and to Levene and Mikeska, dextro-lactic acid is correlated with dextro-chloropropionic acid, whereas Freudenberg correlates it with levo-chloropropionic acid. In the succinic acid series, Clough, Holmberg, Levene and Mikeska correlate dextromalic with dextro-chloro- or bromosuccinic acid, whereas Freudenberg and Kuhn correlate it with levobromosuccinic acid.

All the conclusions were reached by indirect methods and therefore need confirmation by more direct methods.

Levene and Mikeska have advanced sufficient evidence for the assumption that in simple aliphatic secondary alcohols the substitution of the hydroxyl by a halogen atom proceeds without Walden Inversion.

Admitting the correctness of this assumption, it is possible to correlate the configurations of the halogeno acids with carbinols, and these have already been correlated with lactic acid. The process by which this task can be accomplished is seen from the following figures:



Thus, on the basis of this set of reactions, dextro-3-chlorobutyric acid is correlated with levo-3-hydroxybutyric acid and hence with levo-lactic acid.

The same conclusion had been reached previously by Levene and Mikeska on the basis of the behavior of 3-hydroxybutyric and 3-chlorobutyric acids on passing from the ionized to the unionized state. In the pair levo-3-hydroxybutyric and dextro-3-chlorobutyric acids the difference $[M]_{ion} - [M]_{acid}$ has a minus sign.

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THE SPECTRUM OF DOUBLY IONIZED POTASSIUM (K III)

A LARGE number of lines of the spark spectrum of potassium appearing in the electrodeless discharge have been classified by the author as belonging to the K II spectrum. (*Proc.*, Amsterdam, 1926; *Zeitschr. f. Phys.*, 38: 94, 1926; *Archives Neerlandaises*, 11: 70, 1928). The remaining lines lay in the region below λ 3500. It was supposed that these lines belong to the higher ionization stages K III and K IV. A list of these lines has been published by the author. Since we now know the spectra of Chlorine I (De Bruin and Kiess, SCIENCE, 68: 356, 1928) and Argon II (De Bruin, *Zeitschr. f. Phys.*, 48: 62, 1928; 51: 101, 1928) it is not difficult to locate the K III spectrum by aid of the irregular doublet law and to find the energy scheme. A doublet and quartet term system has been found. The key to the analysis is given by the deep $4s^4P_{321}$ with the term differences $\Delta\nu = 1265.9$ and 773.5. The low $4s^2P_{21}$ has the difference $\Delta\nu = 1506.9$. In the following table we give as an example the principal multiplets of the quartet sys-

		$4s^4P_{321} - 4p^4P_{321}$	
5	3513.88	28450.4	$4s^4P_1 - 4p^4P_2$
6	3468.32	28824.2	$4s^4P_2 - 4p^4P_3$
3	3448.01	28993.9	$4s^4P_1 - 4p^4P_1$
6	3420.82	29224.4	$4s^4P_2 - 4p^4P_2$
3	3358.43	29767.3	$4s^4P_2 - 4p^4P_1$
6	3322.40	30090.1	$4s^4P_3 - 4p^4P_3$
6	3278.79	30490.3	$4s^4P_3 - 4p^4P_2$
		$4s^4P_{321} - 4p^4D_{4321}$	
5	3056.84	32704.0	$4s^4P_1 - 4p^4D_2$
6	3052.07	32755.2	$4s^4P_2 - 4p^4D_3$
3	3023.43	33065.4	$4s^4P_1 - 4p^4D_1$
6	2992.42	33408.0	$4s^4P_3 - 4p^4D_4$
5	2986.20	33477.6	$4s^4P_2 - 4p^4D_2$
3	2954.33	33838.8	$4s^4P_2 - 4p^4D_1$
5	2938.45	34021.6	$4s^4P_3 - 4p^4D_3$
1	2877.31	34743.6	$4s^4P_3 - 4p^4D_2$
		$4s^4P_{321} - 4p^4S_2$	
5	2689.90	37165.0	$4s^4P_1 - 4p^4S_2$
5	2635.11	37937.8	$4s^4P_2 - 4p^4S_2$
6	2550.02	39203.0	$4s^4P_3 - 4p^4S_2$

tem. In successive columns appear the intensities, wave-lengths, wave-numbers and term combinations of the spectral lines.

The details of the investigation will appear soon.

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VARIATION IN SIZE OF PLASTIDS IN GENETIC STRAINS OF ZEA MAYS

IN connection with physiological studies of different genetic types of *Zea Mays*, a remarkable variation in the size of the chloroplastids has been observed. While in most strains the mature chloroplastids vary from 6 to 7 μ or from 7 to 8 μ in their longest dimension, one strain has been found which has green chloroplastids only 3 to 4 μ in diameter, and several strains have been studied which have chloroplastids ranging from 10 to 25 μ in their longest dimension. There seems to be no definite relationship between size of plastid and development of the chloroplastid pigments, as has been indicated in earlier studies concerned with the development of the chloroplastids of maize. Strains of albino maize occur which also have giant plastids, so that albinism can not be due to a failure of the plastids to reach a certain size regarded necessary for the development of the chloroplastid pigments. There is a direct correlation between number and size of plastids in individual cells of plants having giant chloroplastids. A mesophyll cell may have as few as two plastids when they are exceedingly large. In cells with few plastids, it may be seen that the plastids are generally paired with respect to size. The giant plastids are often in the process of division, so that it is not difficult to find plastids in all stages of division to form daughter plastids.

So far as studies have been made the variations in the size of plastids in maize appear to be inherited.

The variation in the size of chloroplastids briefly referred to above is interesting in view of the general uniformity in size of plastids which apparently prevails in all of the plant groups above the algae. In 215 species of plants belonging to many families of Bryophytes, Pteridophytes and Spermatophytes, Mobius[1] found 105 to have plastids 5 μ, 70 to have plastids ranging from 3 to 5 μ, 31 to have plastids ranging from 5 to 7 μ and 9 to have plastids from 7 to 10 μ in their longest dimensions. It is assumed that the general uniformity in the size of the chloroplastids in the plants above the algae is associated with the photosynthetic process. The average size of plastid, 5 μ in diameter, as determined from the species studied, is thought to have the surface-volume ratio best suited for the adsorption of the plastid pigments and most favorable for the annexing of the molecules of carbon dioxide to the chlorophyll. This uniformity in size of plastid is regarded to have much the same significance in the assimilation process as the uniformity in the pigment-content of the chloroplastids of different plants as established by Willstaetter and his coworkers from a study of some two hundred species of plants.

In the literature are described a few non-alga plants which do not have numerous small chloroplastids in their cells, among which may be mentioned the genus *Anthoceros* of the Bryophytes, several species of *Selaginella* and *Peperomia metallica* Lind. The cells of *Anthoceros* usually have two (often more in the epidermal cells) chloroplastids. The cells of *Selaginella Martensii* and *S. grandis* have only a single chloroplastid, while the assimilation cells of *S. Kraussiana* have from one to two chloroplastids. According to Schurhoff[2] the palisade cells of *Peperomia metallica* Lind. have four large chloroplastids, while the spongy parenchyma cells have a variable number of smaller chloroplastids. The plastids of the palisade cells reach a maximum size of 24 μ in their longest dimension. Alexandrov[3] has found the chloroplastids of the leaf cells of *Portulaca oleracea* to vary from 5 to 6.5 μ (3.5 μ in the epidermal cells) when they do not contain starch, but as starch is stored the plastids undergo enlargement so as to reach the unusual size of 23 μ in their longest dimension. A similar relation between size of plastid and amount of stored starch, in so far as the giant chloroplastids are concerned, appears not to exist in the genetic strains of maize studied, for the plastids are large even when the plants are protected from the light, and giant plastids occur in albino plants which are unable to synthesize carbohydrates.

The strains of maize which differ widely in size of plastids should serve as useful tools in the study of the plastid as a permanent cell organ and in the determination of the relation between plastid size and photosynthetic efficiency.

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[1] 1920, Mobius, M., "Ueber die Grösse der Chloroplasten," *Ber. d. Deutsch. Bot. Ges.*, 38: Heft 6.

[2] 1908, Schurhoff, P., "Ozellen und Lichtkondensoren bei einigen Peperomien," *Beihefte z. Bot. Centralbl.*, Bd. 23, Abt. I.

[3] Alexandrov, W. G., *Ber. d. Deutsch. Bot. Ges.*, 43: 325–332, 1925.